

Chemical Engineering

A MCGRAW-HILL PUBLICATION

DECEMBER 14, 1959

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Use Clay to Lock Up

RADIOACTIVE WASTES

HOT WASTES: TREATMENT & DISPOSAL
SHIVER-CELLER ETHICS
WHY ENGINEERS ARE UNHAPPY

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PAGE
THREE

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FILTER

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... EimcoBelt filter's new operating principle removes the medium from the drum every filter cycle for cake discharge and cloth washing. No "time out" for cleaning is necessary.

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THE Washington Farmers' Co-operative Association in Seattle decided to launch something new—big-scale distribution of chemical liquid fertilizers. One of their toughest problems was to get the basic ingredients, such as green phosphoric acid and traces of nitric and hydrochloric acid, from storage to mixing tanks, without corroding the piping.

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For information on how B.F. Goodrich Koroseal can make your opera-

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B.F. Goodrich Industrial Products Co.
Dept. CE-12, Marietta, Ohio

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Name

Company

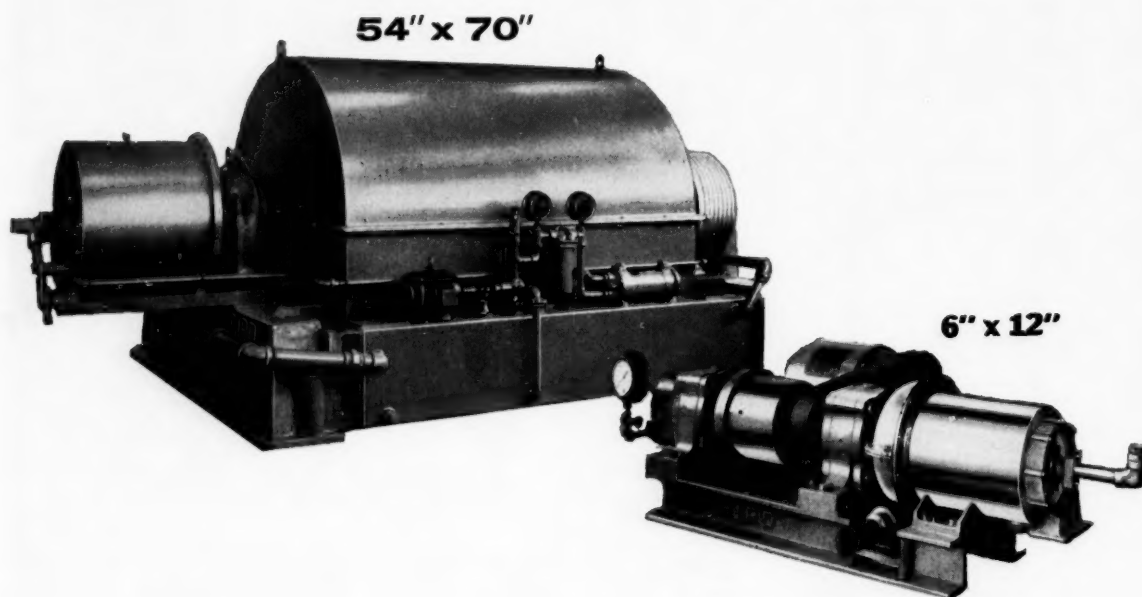
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December 14, 1959

Chemical Engineering

Vol. 66 No. 25

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

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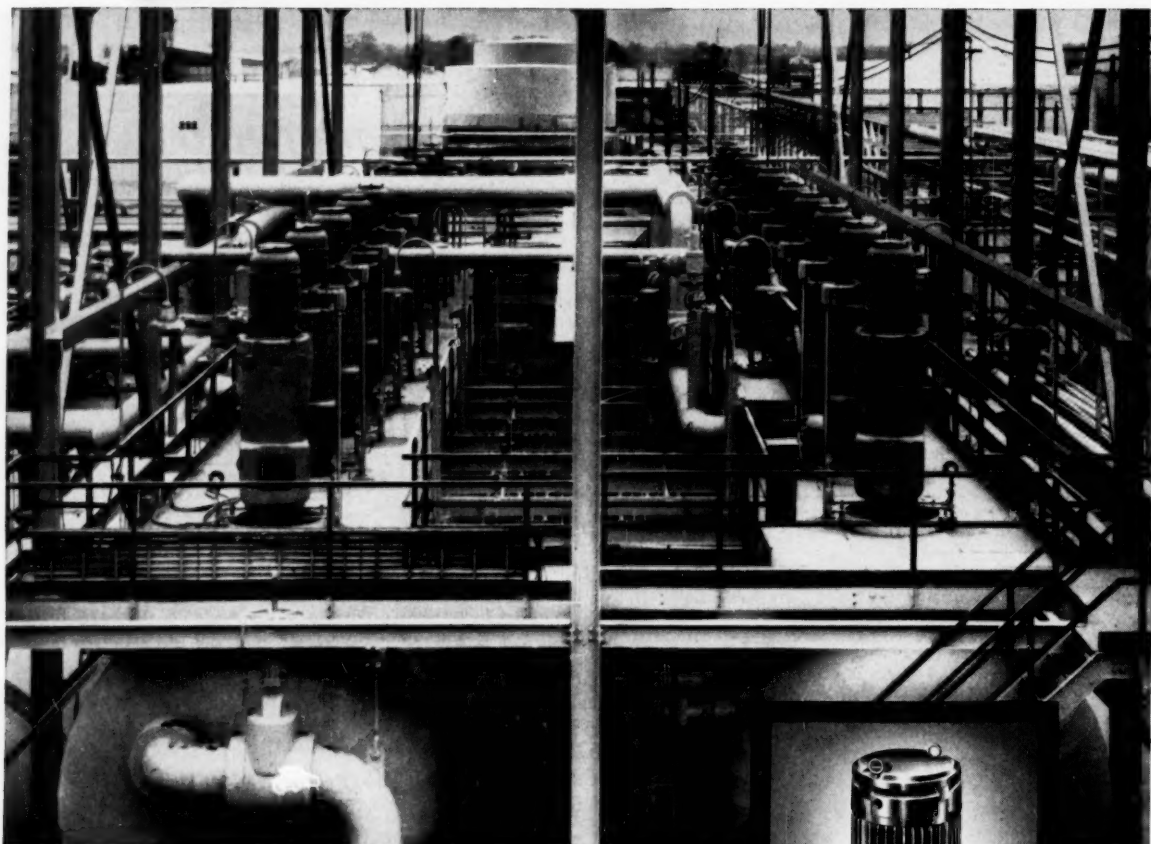
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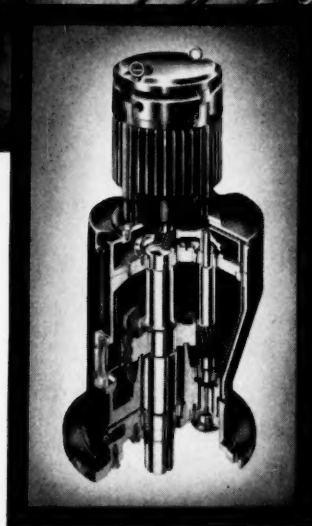
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50 HP Philadelphia Mixers in continuous operation...

PROOF OF BETTER SHAFT SEALING.

Each of the forty-two Philadelphia Mixers in this pressure vessel mixing operation can produce 99,000 pound-inches of torque for continuous operation under difficult loading conditions . . . the kind of job where anything less than the best agitator shaft operation is an invitation to mechanical seal problems. *Significance:* Philadelphia Mixers have two important advantages over *all* other fluid mixers which assure best output shaft performance in difficult operations.



FIRST. In any comparative evaluation of mixers having equivalent torque capacity, a Philadelphia Mixer will *always* have the largest, heaviest duty, highest capacity bearings . . . and the drive with the best bearing support for shafting will have the truest running shaft.

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If One of these Six Materials is Best for Your Process

tantalum

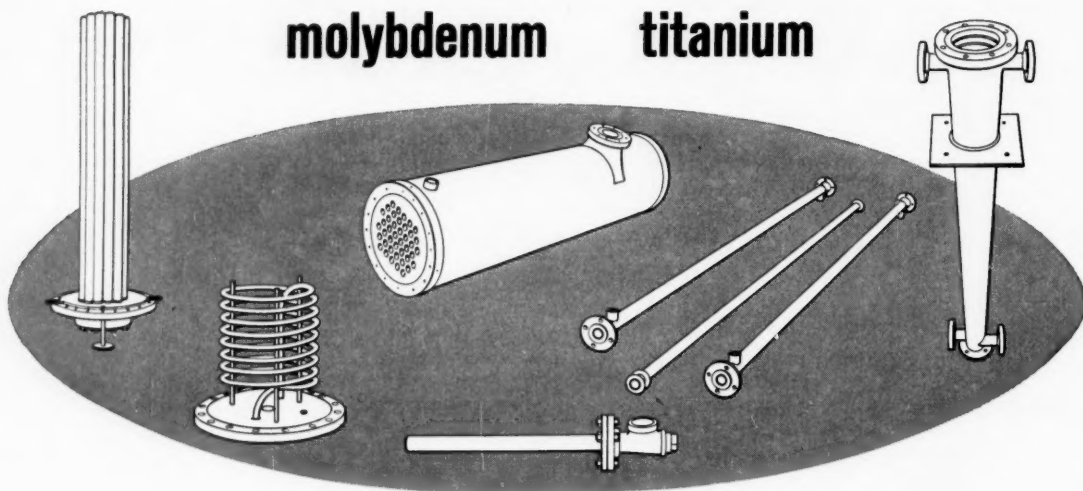
tungsten

columbium

zirconium

molybdenum

titanium



That's the One you'll get in Fansteel Equipment

"There's no middle ground with tantalum . . . its use is either pointless or imperative." We said that back when we first introduced tantalum chemical equipment and it's still true. And we recommend tantalum *only* when it is the best and most economical material for the job . . . when any other metal would surely fail.

This most remarkable metal is used in chemical equipment because of its phenomenal resistance—its immunity—to acid corrosion. And although Fansteel is the world's largest producer of tantalum metal and tantalum equipment, we recommend and fabricate equipment of other materials when:

- tantalum's unique qualities would obviously be wasted under less than severe conditions,
- conditions other than those requiring tantalum's complete corrosion immunity might

be the real problem. These conditions may be excessive heat, wear, abrasion or impact. And in such cases, Fansteel engineers will suggest the use of other materials with or without tantalum.

Fansteel's experience with tantalum, columbium, molybdenum, tungsten, zirconium and titanium benefits you three ways:

1. You are sure that the correct metal will be used on your particular application;
2. You have the convenience and the familiarity of a one-source supply, and
3. You get equipment designed, engineered and built by men who know the materials as well as the fabricating techniques . . . men with the basic experience that comes only from years of producing corrosion control equipment.

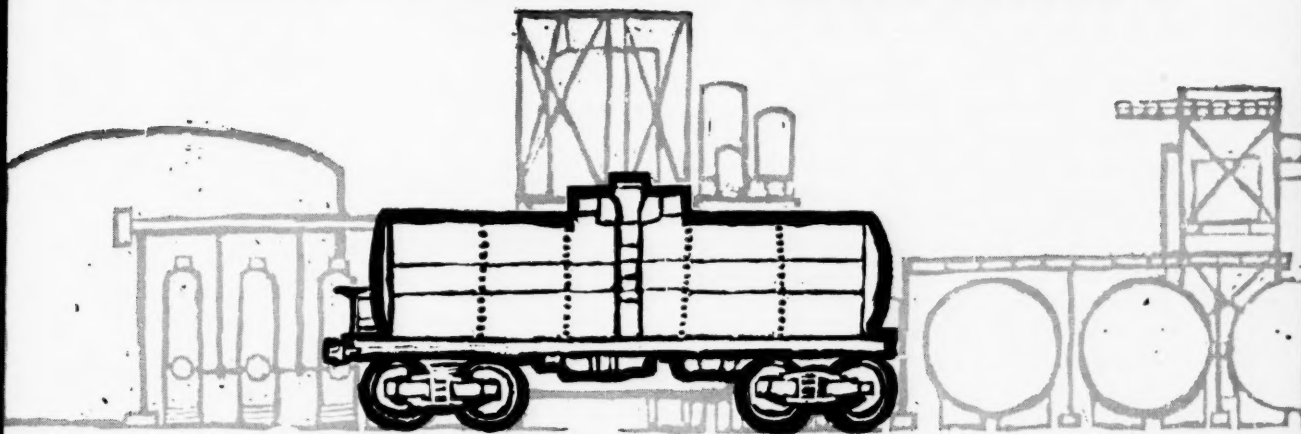


Talk to your Fansteel representative about your chemical process equipment problem, or address inquiries to the Equipment Department, Metals Fabrication Division. Samples of metals for testing are available upon request; arrangements can be made for the loan of certain equipment for pilot operations or heat transfer studies.

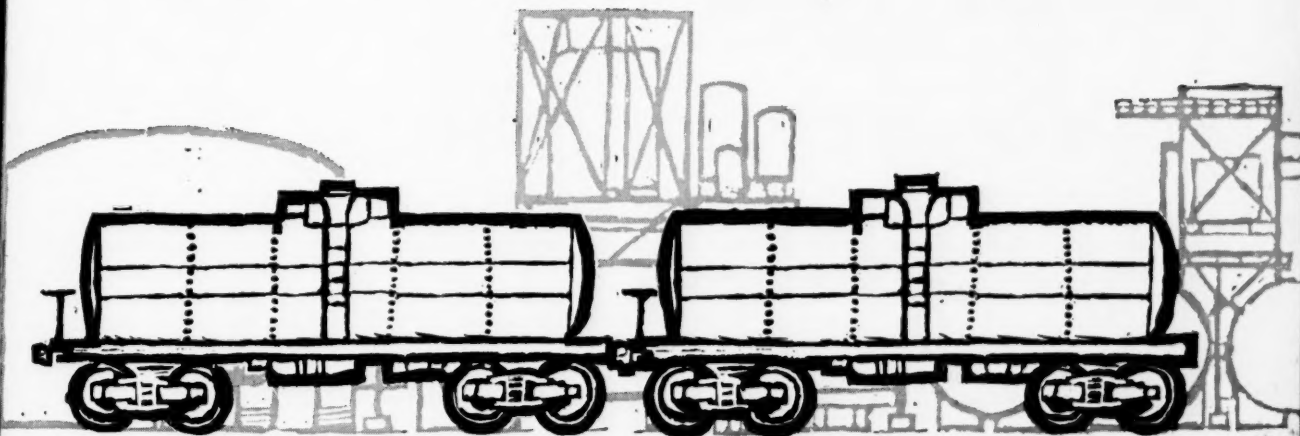
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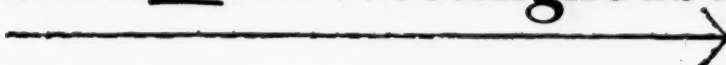
Olin Mathieson did and doubled production



Olin Mathieson doubled production and reduced overhead at their Chlor-Alkali Plant in McIntosh, Alabama. Engineered and constructed by the Blaw-Knox Company, capacity was doubled at a cost of only two-thirds the initial investment.

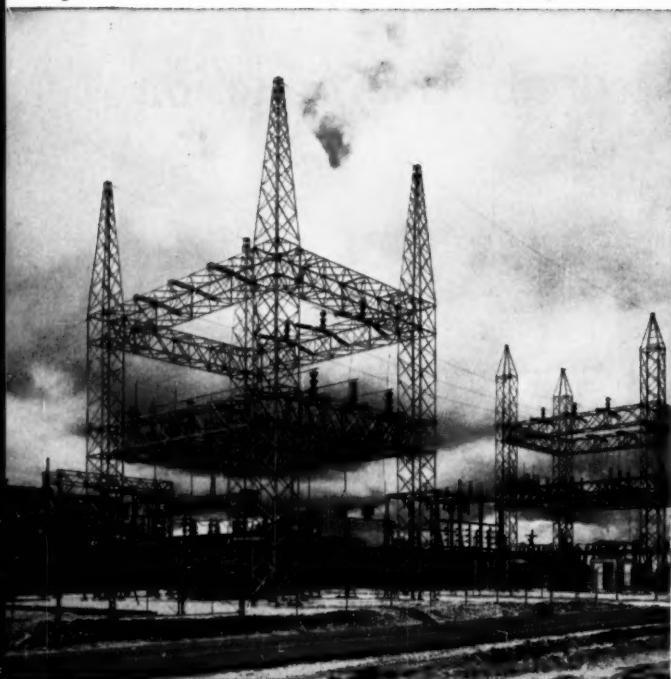
If you want more capacity to meet the doubled production required by 1965, your Westinghouse representative can help you with a practical solution.

YOU CAN BE SURE...IF IT'S **Westinghouse**



here's how Olin Mathieson

Olin Mathieson Chemical Corporation's Chlor-Alkali Plant built by Blaw-Knox Company at McIntosh, Ala.



Twin modern substations equipped with Westinghouse metal-clad switchgear provide superior circuit protection. Fast and positive arc interruption is assured.



High mechanical and dielectric strength are two of many plus benefits of the design used in these Westinghouse transformers.

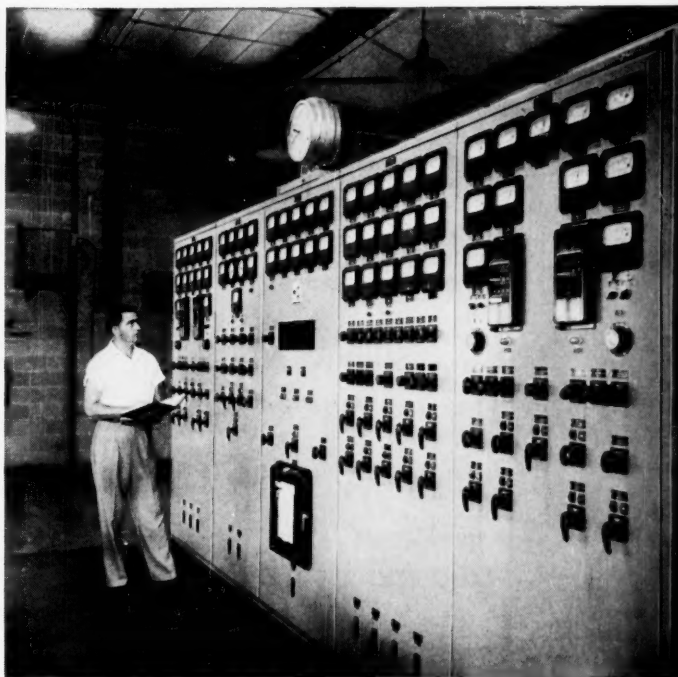
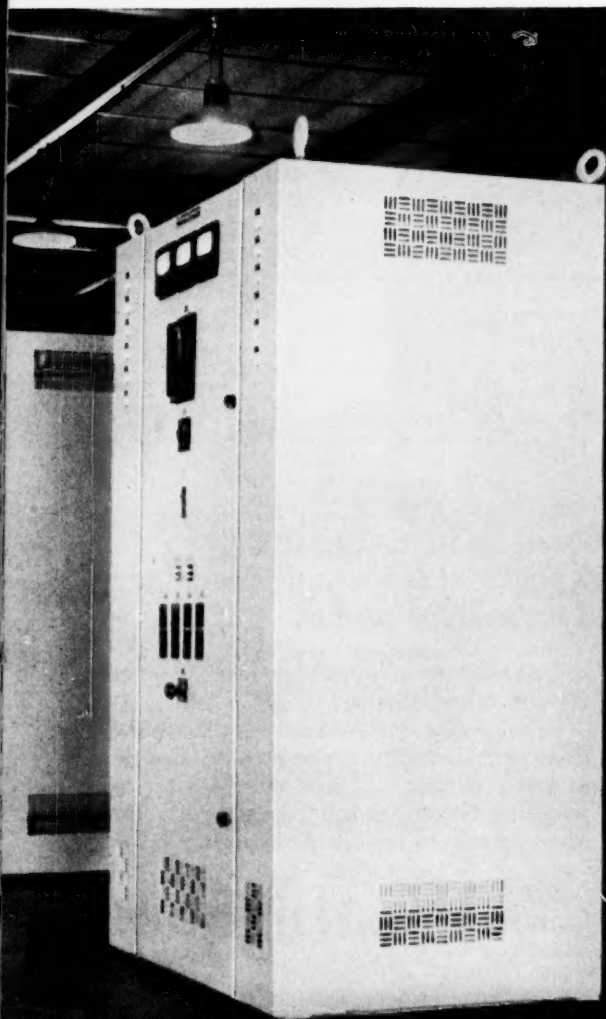
These Westinghouse rectifier auxiliary control cubicles provide smooth, fast variation in output voltage for the exacting demands of electrochemical processing. Here, under constant full capacity load, Westinghouse rectifiers have proved their ability to perform efficiently and with a minimum of maintenance.

POWERED-UP with Westinghouse



Blaw-Knox, the general contractor, had future expansion in mind when planning started on Olin Mathieson's Chlor-Alkali Plant to be built in McIntosh, Alabama. They determined the electric energy requirements. Then, Westinghouse engineers worked out the most efficient and economical equipment and control to meet these specifications. Westinghouse, Blaw-Knox and Olin Mathieson, working together, decided on certain oversized equipment in anticipation of future needs. This planning paid off. In 1957, capacity was doubled at a cost of \$8,000,000 as compared to the initial investment of \$12,000,000.

The present daily consumption of electrical energy at this plant is 1,000,000 kilowatt-hours—equal to the power requirements of a city with a population of 300,000.



This custom designed duplex switchboard installation controls and supervises the electrical circuits. Walk-in cubicle construction makes maintenance easy with equipment protected yet readily accessible. Uniform appearance of all instrument and relay Flexitest* cases gives unit clean, modern appearance.

*Trade-Mark

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Westinghouse

here's why you should plan now to *POWER-UP FOR PROFIT ELECTRICALLY*

forecast use of electric power
in the chemical industry

59 BILLION
KWH

81 BILLION
KWH

139 BILLION
KWH

1958

1963

1968

To stay competitive, you will be investing in
a tremendous increase in electrically powered processing machinery.
Be sure it is engineered to produce profits.

Power-Up is a Westinghouse program to help you increase profits through greater productivity. In your plant it may be a materials handling system, higher capacity machinery, or a more productive environment through higher lighting levels and air conditioning. One thing is certain—whether or not you earn satisfactory profits in the '60s

will depend on your making maximum use of low-cost kilowatthours.

Be sure—like Olin Mathieson—that your electrical equipment is engineered to produce profits as well as output. Call your Westinghouse representative. He can tell you the electrical steps you can take *now* to start your Power-Up program.

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THE VALVE AND FITTINGS ANSWER CORNER



Send in your questions on stainless valves and fittings to Carl Tylka, Cooper Alloy Technical Service Director.

Q. Is it possible to obtain a valve which, like a globe valve, possesses linear throttling characteristics, but which also, like a gate valve, has low fluid pressure drop across it when fully opened?

A. Not throughout the entire flow range of the size valve being considered. A very close approximation, however, may be attained with a Flex-Plug type design (a unique new valve patented by Cooper Alloy), which provides linear throttling response up to 90% of full valve flow. The 10% balance of the upper flow region would exhibit a typical gate valve flow pattern.

Q. How can one prevent oxidation of active ferrite ion on the fluid side of a cast stainless valve body?

A. This type of corrosion is commonly found on untreated cast stainless surfaces only, and may be caused by foundry, machinery, and handling techniques. Proper pickling and passivation with thorough mechanical cleaning will generally rectify this, though in some cases actual weld repair of the contaminated surface is required. Since this is a surface condition only, machining or grinding will also help.

Q. What type of valve do you recommend for manual-control services where minimum pressure drop is required?

A. In the absence of more detailed knowledge of the problem, I would tentatively recommend an angle valve. The pressure-drop characteristics of this type valve are less than 50% those of conventional globe valves.

Q. Is it advisable to specify installed valve position on an order?

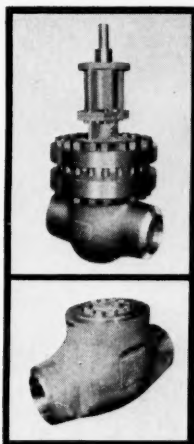
A. Definitely. By inclusion of this information, definite design considerations can be incorporated, especially in cases where backseat leakages are critical and mechanical valve operation is involved.

Q. Is it advisable to install valves smaller than the accompanying pipe sizes?

A. Where flow and pressure considerations so permit, it is not only advisable but also economically beneficial.

Q. Why aren't valve bodies with butt weld and connections made shorter?

A. To prevent distortion of the seating surfaces during installation. The longer length is required for heat dissipation during welding.



Above left, Cooper Alloy 16" cast stainless gate valve ready to receive gear motor drive; lower left, Cooper Alloy 12" cast check valve. Both are rated for 2500 psi service at 670°F. Official AEC photo above shows them in place in nuclear process line.

Cooper Alloy cast stainless valves spurt ahead of competition to win acceptance in AEC's Spert III reactor program

Cast yield strengths of 23,000 psi, plus cost savings of 40%, do the trick!

This is a Cooper Alloy success story in another "first": casting of stainless valves and fittings to strength levels actually surpassing those previously possible only in forgings—and doing it all at a 40% saving to the customer!

The story starts, naturally, with the AEC's valve and fitting specifications, which are rugged indeed. They have to be certified to function continually at elevated pressures and temperatures (2500 psi, 670° F.), under which conditions leakage, corrosion, and other operational problems are magnified enormously over those encountered in normal process work.

Prior to turning to Cooper Alloy, the contractor for the AEC cancelled a large valve order from another supplier, because the latter could not meet the exacting physical specs without changing the material specs. Cooper Alloy was given the order on the basis of producing to meet AE and AEC specs. Cooper Alloy valves and fittings are currently in operation in the AEC's Spert III installation at Arco, Idaho. Included are nuclear

fittings, and motor and manual operated gate, globe, and check valves in various sizes.

How does Cooper Alloy do it? Through the use of the most advanced foundry methods, meticulous attention to conditions, and an exact balance of chemical composition to develop the maximum strength characteristics inherent in the complex structure of stainless alloys. All products, naturally, are elaborately tested and guaranteed before delivery.

As if the AEC's specs were not stringent enough, there is now a bonus to the story: during production, Cooper Alloy technicians worked out ways of producing cast strengths higher than those required, and proceeded to produce all fittings and valves to these higher, self-imposed standards—at cost savings of 40% over forged valves and fittings!

Unusual, yes, but not to Cooper Alloy. It's typical of the quality bonus you get when you buy from Cooper Alloy. For further information, write to Cooper Alloy Corporation, Hillside, N. J.


DE LAVAL STEAM TURBINES

for process industries



The photograph above shows a De Laval direct-connected turbine generator installation at Parke, Davis & Co., Detroit, Michigan.

This controlled extraction, controlled back-pressure unit supplies 2000 kw using process steam. Extraction is at 130 psig, exhaust is 5 psig. This new machine was added to already existing De Laval units that have been in service for 30 years. In addition, the Parke-Davis Research Laboratories in Ann Arbor, Michigan will soon be using a new 1000 kw unit.



Parke, Davis & Co. uses DE LAVAL Steam Turbines for process and power generation

Proved economy, dependable service

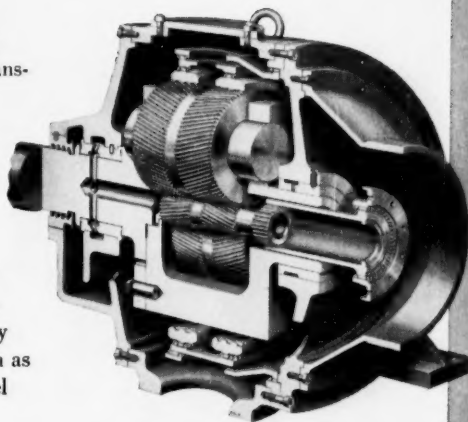
In many process industries, an important by-product is economical electric power. If appreciable quantities of process steam are used, power generation can be achieved at comparatively low cost.

De Laval, pioneer in high speed rotating machinery, has continued to maintain engineering and manufacturing leadership. If you have process application where low-cost power generation can be utilized, call on De Laval.

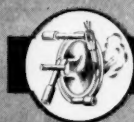
De Laval-Stoeckicht Planetary Gears

In many applications where high speed and high horsepower are transmitted, the De Laval-Stoeckicht planetary gear can be used to great advantage. It is also used as a speed increaser or decreaser in many industrial installations.

Among its outstanding characteristics are light weight, in-line construction and space saving. It may be used for all kinds of drives such as gas turbines, steam turbines, diesel engines, etc.



Write for Bulletin 2400



DE LAVAL

Steam Turbine Company

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See why ALCOA ALUMINUM makes a good design habit

Requirement: Low-cost, corrosion-resistant piping with high bursting strength

Key to good design: Specify Alcoa Aluminum alloy piping

Where product protection, corrosion resistance and high bursting strength are of foremost importance in a process, aluminum piping is the answer. ALCOA® Aluminum Pipe is the least expensive for doing the job most satisfactorily. It does not catalyze the decomposition of many sensitive chemicals as other metals do. It resists attack by materials within the pipe, as well as by corrosive environments outside. And its clean, easily maintained appearance is ideal for food processing plants where sanitary conditions are important.

With ALCOA Aluminum Pipe you also get a smooth, low friction surface, high thermal conductivity and nonsparking characteristics . . . all highly desirable qualities.

In ultra-low temperature applications, ALCOA Aluminum Pipe retains its excellent physical properties without embrittlement. Tests to as low as -423°F show it actually grows in strength as the temperature drops. That's why it is specified for tonnage oxygen, nitrogen, hydrogen and helium service.

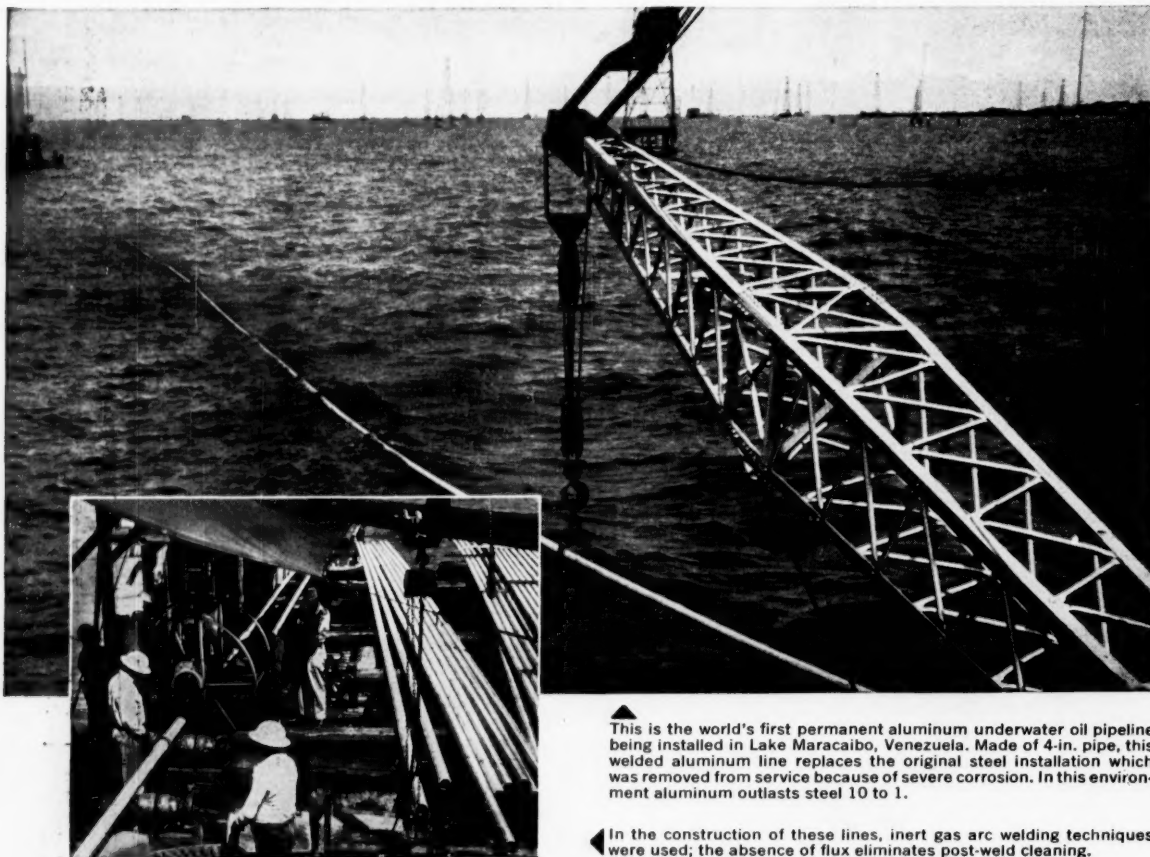
ALCOA Aluminum Piping is regularly produced in ASA sizes from $\frac{1}{8}$ in. through 12 in., and in a variety of alloys and

temper, some as strong as low carbon steel. Seamless pipe in sizes up to 20 in. in diameter is available on special order.

ALCOA engineers have worked closely with all segments of the process industries for over 40 years, and can help you specify the aluminum alloy pipe best suited for your process application. ALCOA's unparalleled experience in this field is available to you for the asking. Write to the address on the coupon, stating your requirements as specifically as possible. ALCOA's development engineers will welcome the opportunity to work with you on your problems.

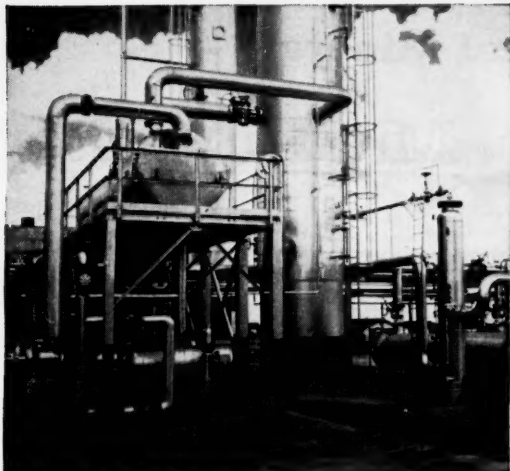
You also can take advantage of the wide selection of free ALCOA literature on aluminum for process piping and other process applications. Simply check the booklets you want on the coupon and mail to the address indicated. ALCOA will forward your material promptly and without obligation.

During 1959, ALCOA will conduct engineering conferences in a number of major cities on process industries applications of aluminum. Contact your nearest ALCOA sales office for full particulars and dates.

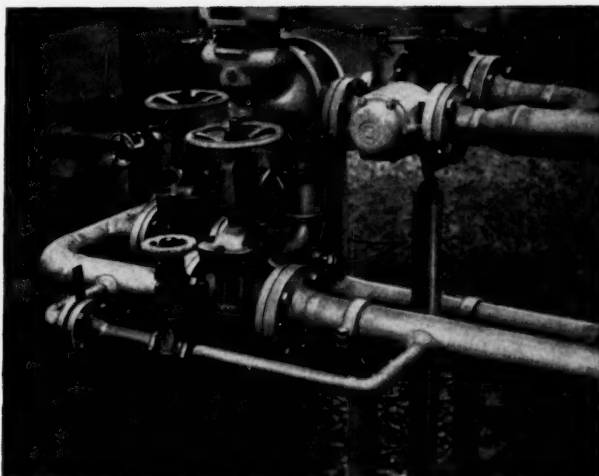


▲ This is the world's first permanent aluminum underwater oil pipeline being installed in Lake Maracaibo, Venezuela. Made of 4-in. pipe, this welded aluminum line replaces the original steel installation which was removed from service because of severe corrosion. In this environment aluminum outlasts steel 10 to 1.

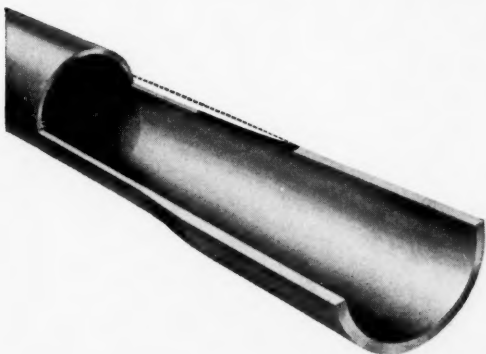
◀ In the construction of these lines, inert gas arc welding techniques were used; the absence of flux eliminates post-weld cleaning.



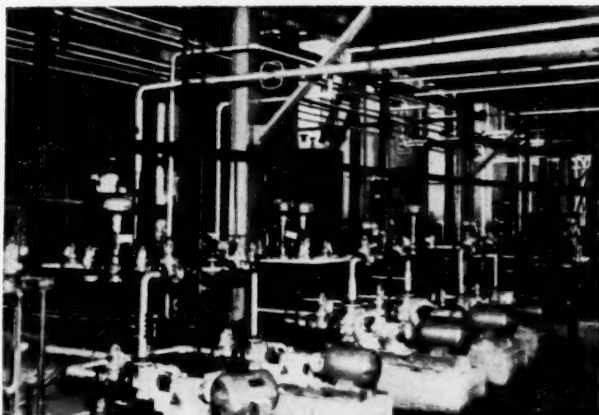
Corrosion and product contamination problems were solved by the use of aluminum in this processing plant. Alcoa Aluminum provides the lowest priced pipe able to resist the action of vinyl acetate and other corrosive liquids such as fuming nitric acid, hydrocyanic acid, acrylonitrile, etc.



Highly resistant to H_2S and CO_2 , aluminum pipe has been proven in service in gas purification plants.



Alcoa's new UNISTRENGTH Pipe cuts cost, cuts weight with no sacrifice in bursting strength. The secret: wall thickness is reduced everywhere but at the ends where it is needed for joining. This compensates for the local reduction in strength caused by the heat of welding on popular heat-treatable pipe alloys. Available in a range of sizes with ends matching uniform wall pipe of the same size and ASA schedule number.



Naval store plants find aluminum pipe and Unitrace ideal choices because they do not discolor or downgrade resin and other pine products.



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| <input type="checkbox"/> 20849 Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres | <input type="checkbox"/> 20935 Designing to Prevent Corrosion |
| | <input type="checkbox"/> 10415 Welding Alcoa Aluminum |

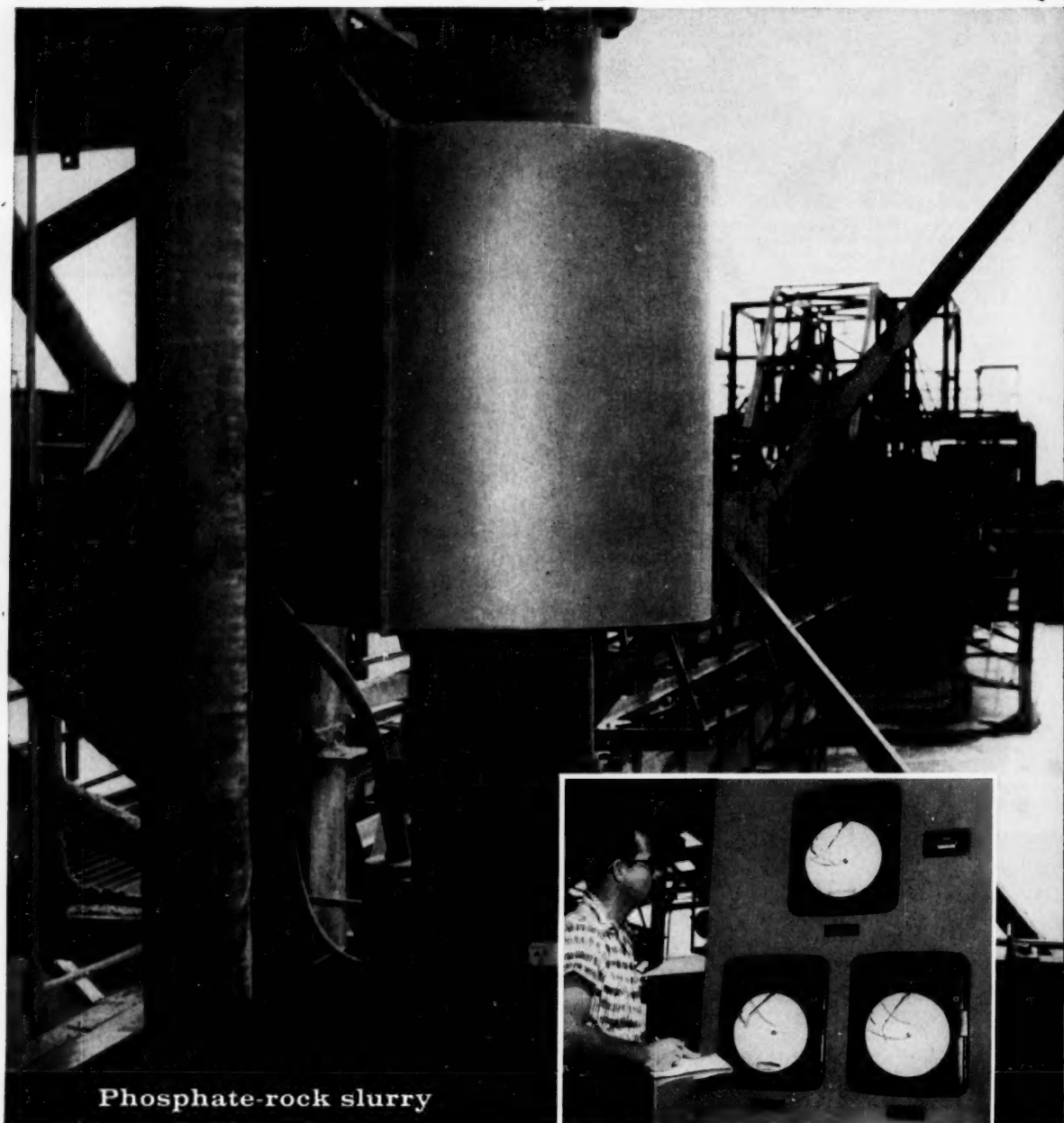
Name

Company Title

Address

City Zone State

at International Minerals -
sand, acid, rock . . . nothing stops



Phosphate-rock slurry

This 16" Foxboro Magnetic Flow Meter is part of a mass-flow system for measuring phosphate rock slurry pumped to flotation plant. Meter measures slurry in gpm, while nearby gamma ray density cell measures density of solution. The two variables are recorded separately, and

their product is then recorded in dry-tons-per-minute on the third Dynalog instrument on the panel above. Recorder readings are telemetered to mine head so operators will know how much rock to feed into pipeline.

the Foxboro Magnetic Flow Meter

**"One meter even
paid for itself in
4 months" -**

reports J. H. Andrews,
senior development engineer

You'd travel a long way to find a process with as many meter-killing liquids as at International Minerals and Chemicals Corp., Bartow, Florida. Phosphate-rock slurries, sand-water slurries, phosphoric acid — yet they're all metered accurately, continuously with Foxboro Magnetic Flow Meters.

The Magnetic Meter is perfect for such "difficult liquids." It has no flow restrictions of any type — nothing to plug up. Instead, electrodes flush-mounted in corrosion-proof meter wall sense flow rate magnetically — send a linear proportional signal to a Foxboro Dynalog* Electronic receiver.

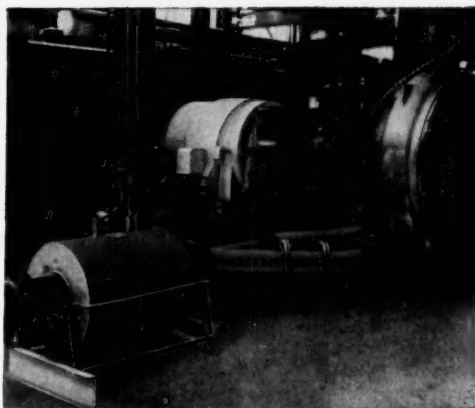
Magnetic Meters are installed as simply as a length of pipe — require no special meter runs, or straightening vanes. Maintenance is virtually nonexistent.

Ask your Foxboro Field Engineer for full details on the high-accuracy, low maintenance Magnetic Flow Meter. The Foxboro Company, 3612 Neponset Ave., Foxboro, Mass.

*Reg. U. S. Pat. Off.

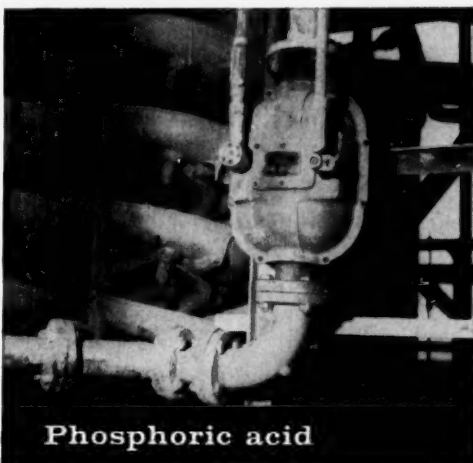
Write for Bulletin 20-14.

FOXBORO
REG. U. S. PAT. OFF.



Sand-water slurry

International Minerals uses this 12" Foxboro Magnetic Flow Meter to control pumping rate of sand and water slurry. Foxboro Dynalog Controller holds pump discharge within $\pm 1\%$ of its 6000 gpm capacity. Slurry is so abrasive, entire pump unit must be replaced every six weeks. Only work done on Magnetic Meter, however, has been one "preventive maintenance" liner replacement during 3 years of continuous operation.



Phosphoric acid

One of six Foxboro 3" Magnetic Flow Meters at International's Bonnie Chemical Works. Meters measure phosphoric acid with better than $\pm 1\%$ accuracy. Although meters have been operating up to 4 years, under highly corrosive conditions, none have ever required maintenance.

Sure Source of top-quality plate work . . .

American Bridge at Orange, Texas.

If your business requires equipment made from steel plate—heavy-wall pressure vessels, tanks, stacks, bins, pipe, etc.—American Bridge invites your attention to its recently modernized plate fabricating facilities at Orange, Texas.

The plant itself, one of the largest in the country, is a huge two-aisle building, 177' wide and 750' long, with crane runways extending 270' and 200' at either end. Equipment includes seven cranes capable of lifting, in combined use, over 100 tons.

Fabricating facilities include large car bottom-heating and stress-relieving furnaces, heavy-plate bending rolls, a variety of presses and press brakes, the latest in welding and X-raying equipment, plate shears, edge planers, boring mills and drills.

These facilities enable American Bridge to handle practically any plate job regardless of size. And great capac-

ity permits the handling of several large jobs simultaneously.

Efficient and economical construction service, too!

American Bridge has the most complete range of construction equipment in the industry, plus skilled personnel backed by over fifty years of experience. *Anything we fabricate, we can erect.*

And, because of the strategic location of our Orange plant on water, rail and truck routes, you can count on fast delivery and low shipping costs.

For top-quality plate work, contact any of the offices listed below. Or write for our booklet which describes the facilities and services available from our Orange plant.

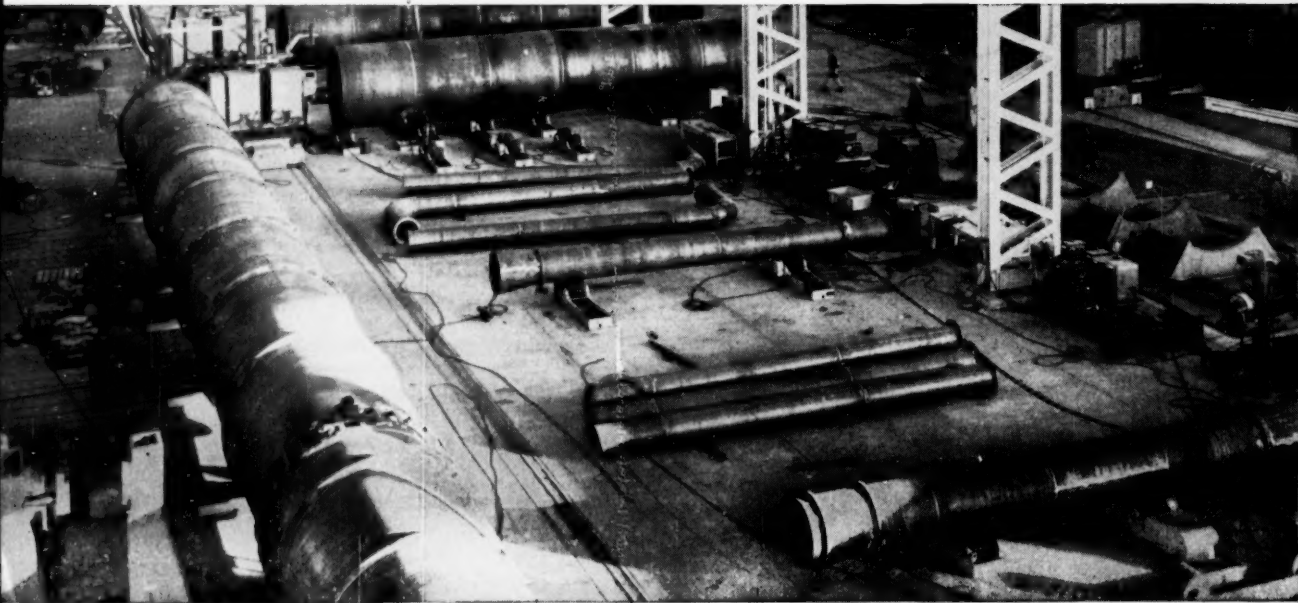
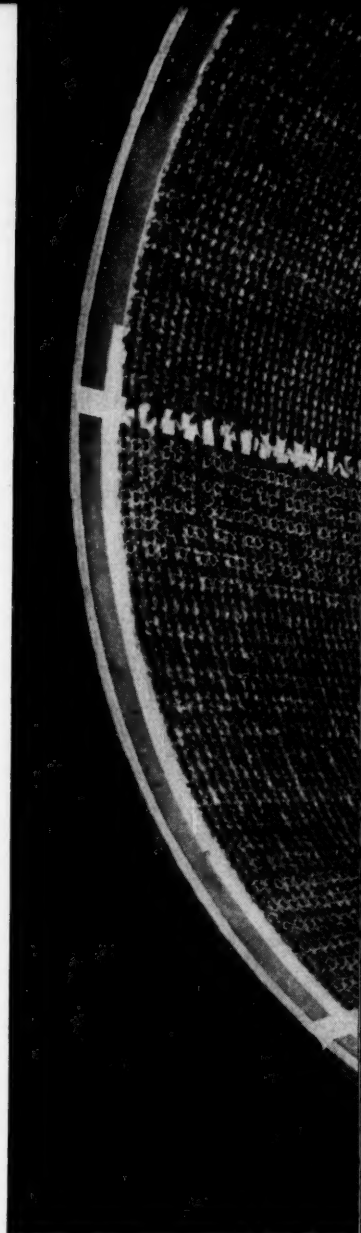
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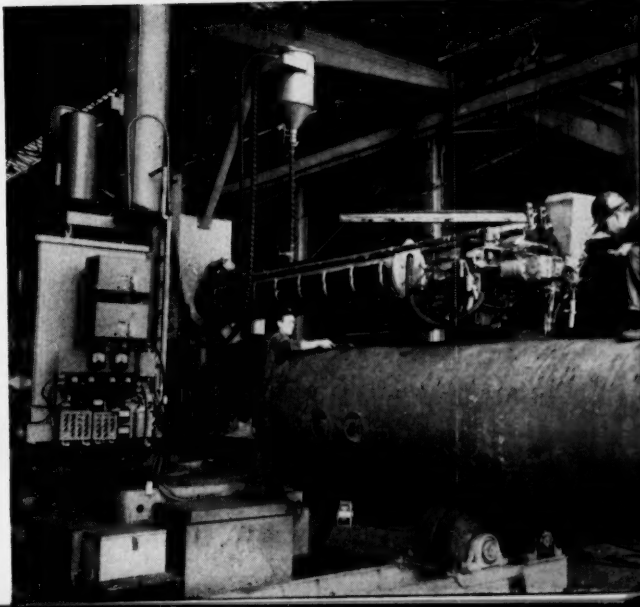
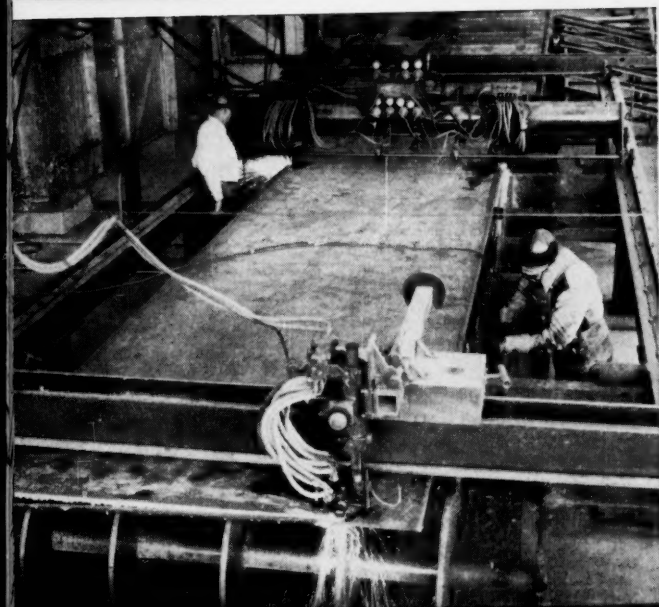
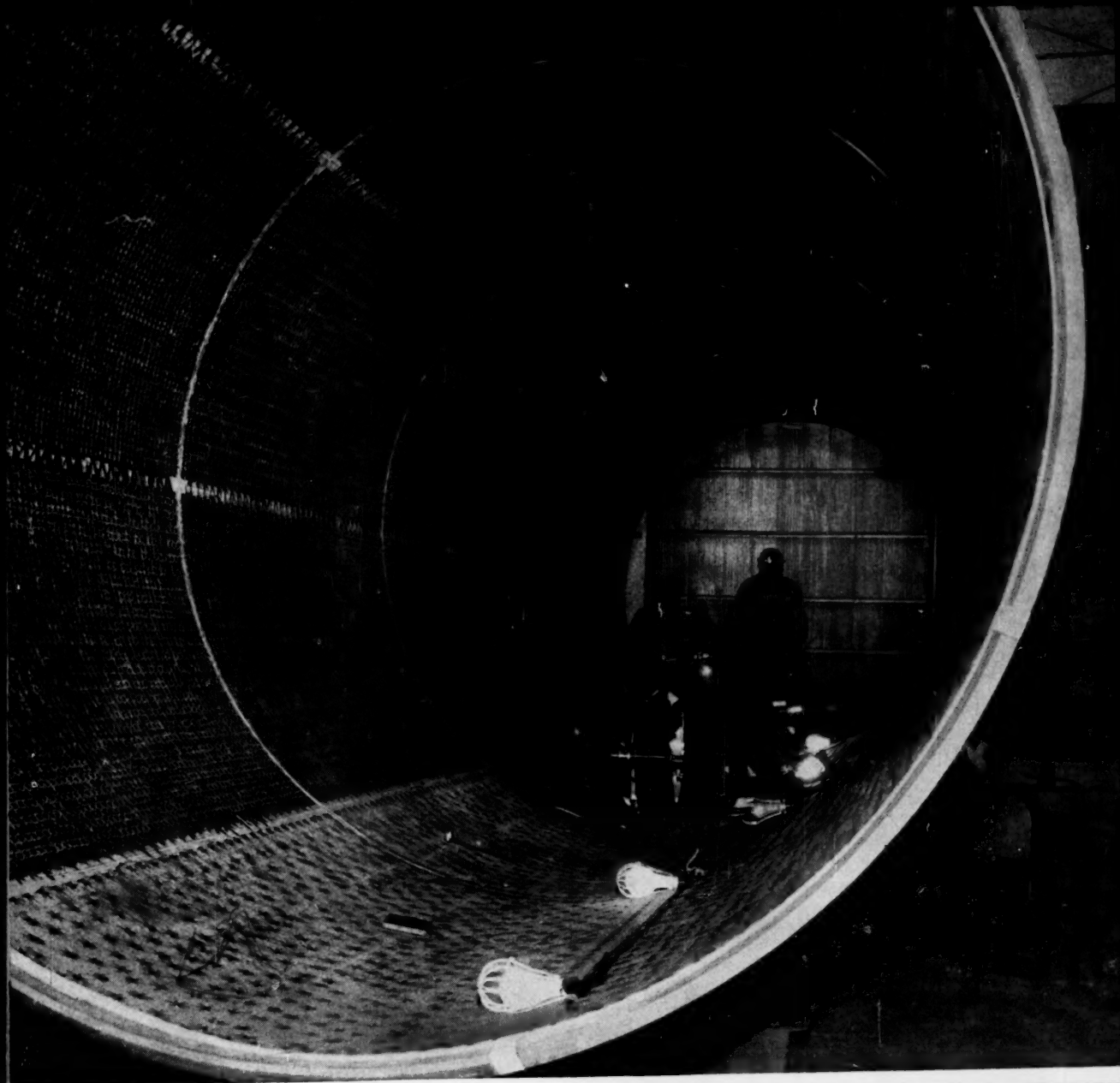


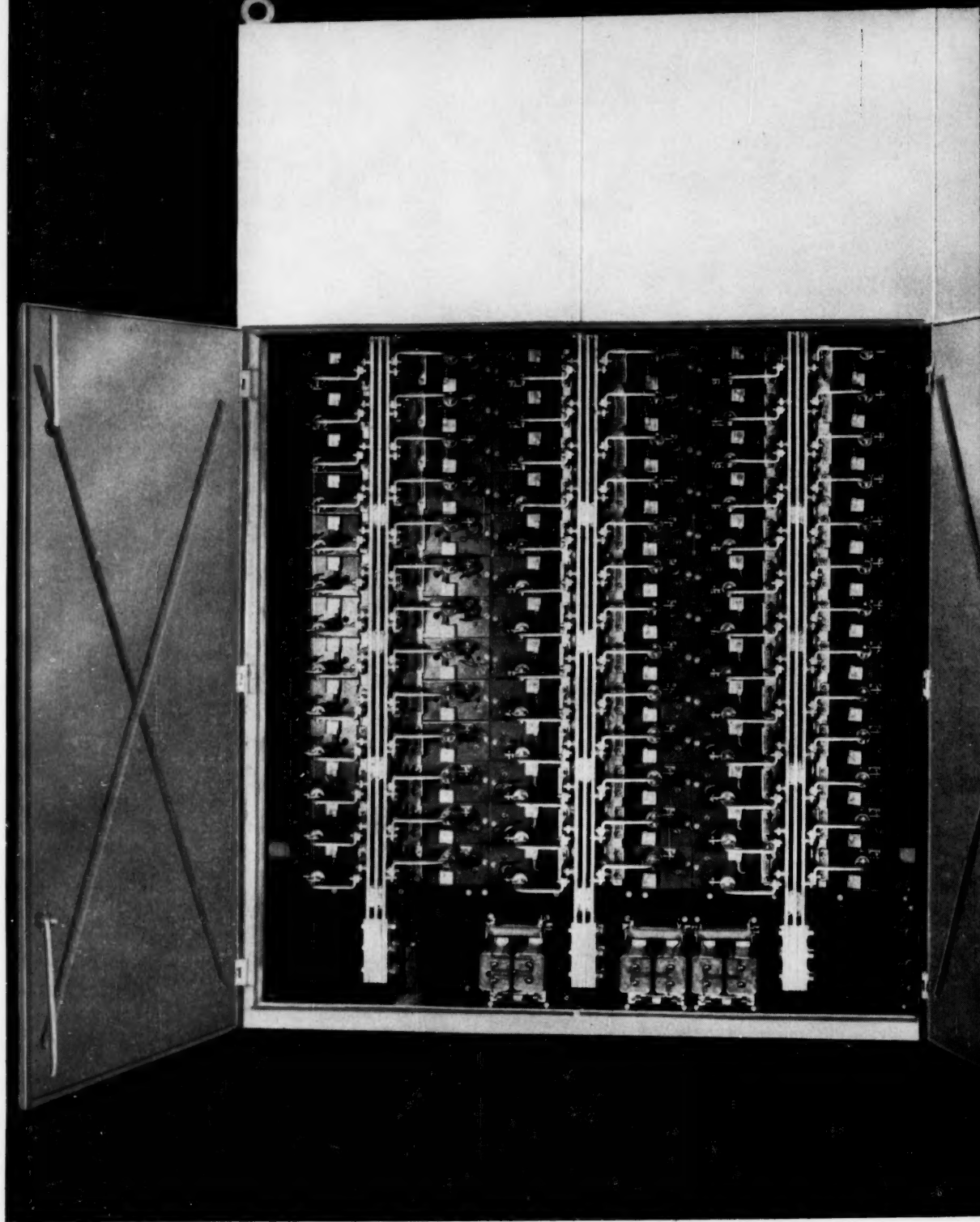
**American Bridge
Division of
United States Steel**

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Now available for all electrochemical processing voltages...

New Westinghouse Silicon Rectifiers Give You Higher Efficiency in Less Space at Lower Cost

Helping you curb the high cost of processing is the job of these new high-efficiency Westinghouse silicon rectifiers. Cost of power—as reflected in final product costs—is now made lower than ever before.

The completely redesigned Westinghouse rectifiers offer you these major advantages...

- **Low first cost** . . . advanced circuitry eliminates complicated excitation equipment and simplifies construction of units.
- **Higher efficiency** . . . 96 percent or better overall, for most voltage applications.
- **Longer life** . . . no detectable aging of silicon cells has occurred even after many years of use.
- **Ease of installation** . . . units are completely

factory-assembled. You need only make a-c and d-c connections.

- **Less space** . . . with new high-voltage silicon cells, maximum power can be built into the rectifier units with space savings up to 50 percent over previous designs. Your costs for buildings are lower.
- **No costly outages** . . . indicating equipment detects infrequent cell failure. Carefully planned design makes replacement of silicon cells simple and fast.

For full information on Westinghouse silicon rectifiers for electrochemical applications, call your Westinghouse representative or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

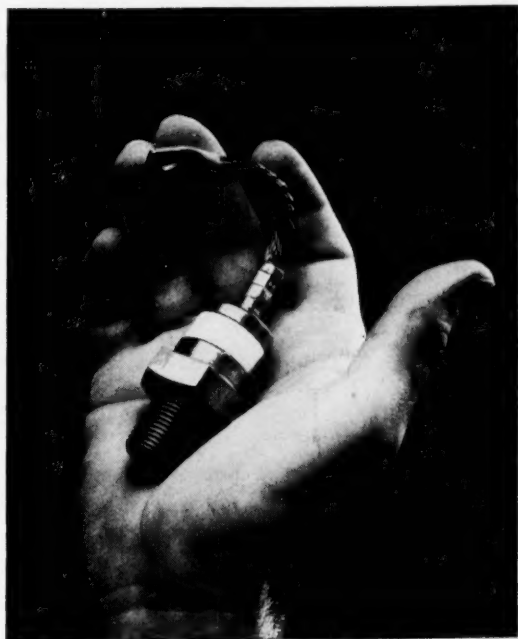
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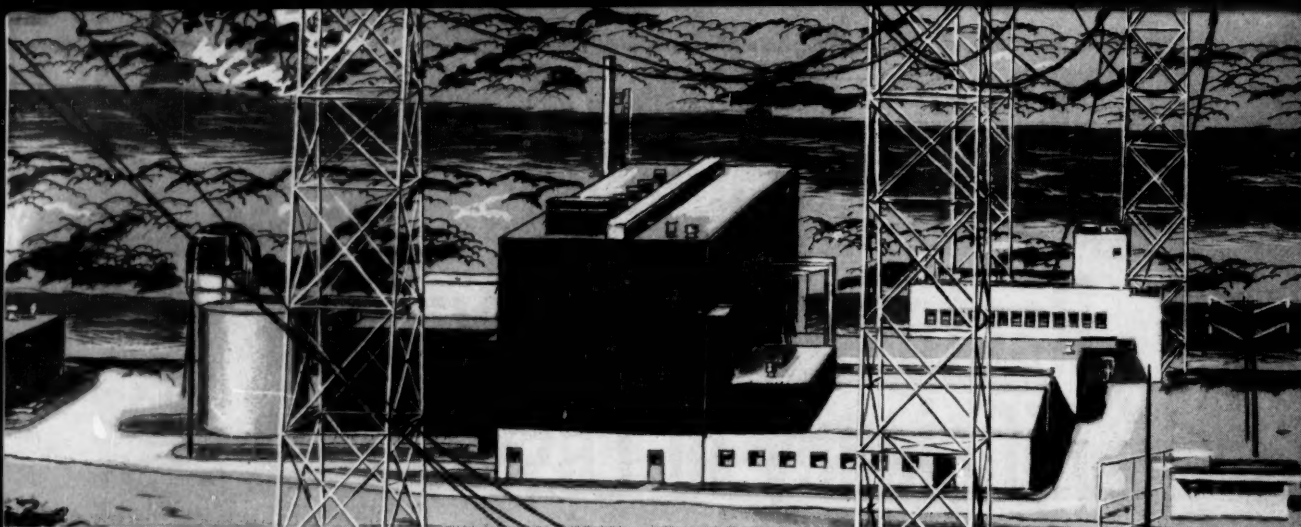
◀ New 10,000-amp, 600-volt, d-c Westinghouse rectifier unit shown here allowed better than 50 percent space saving over the previous unit used in this type of service.

Typical high-power Westinghouse silicon rectifier cell, hermetically sealed for longer operating life and higher reliability. ▶

YOU CAN BE SURE...IF IT'S
Westinghouse

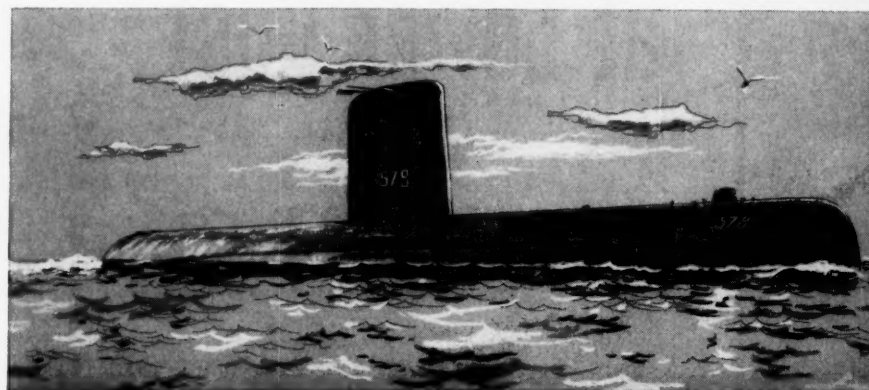
WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV FRIDAYS



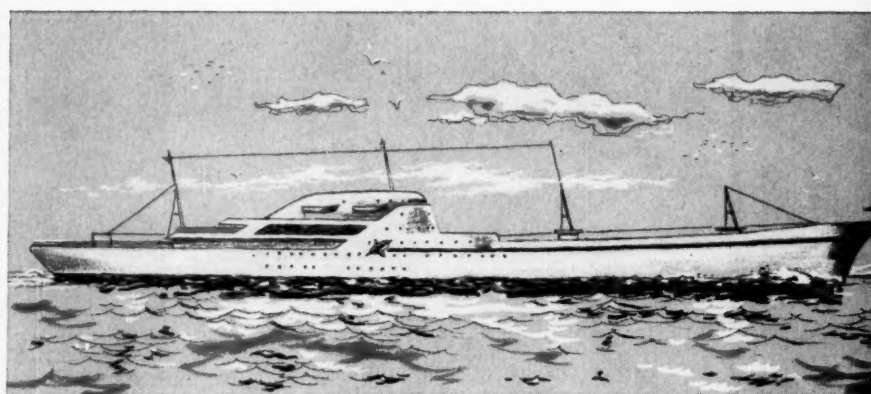
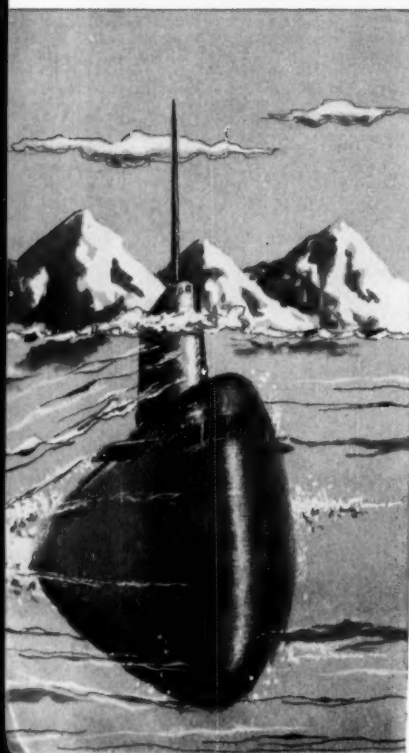


Shippingport Atomic Power Station—first United States full-scale central station atomic power plant devoted exclusively to civilian needs. First produced power on the line 12:39 A.M., December 18, 1957.

U.S.S. Skate—world's third nuclear-powered submarine. Crossed North Pole on August 11, 1958.



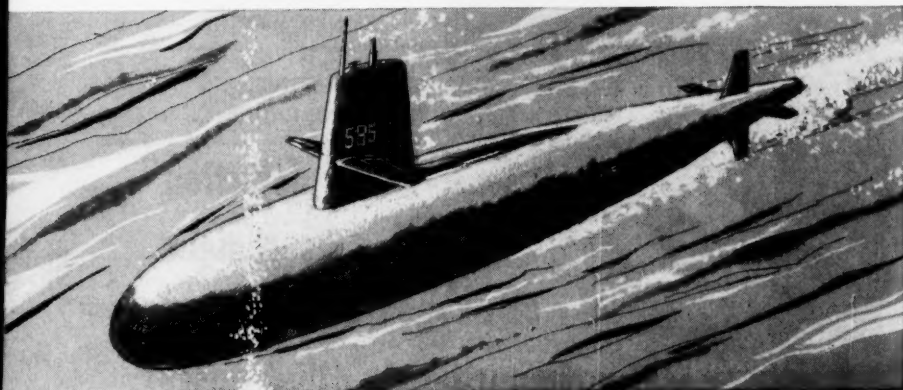
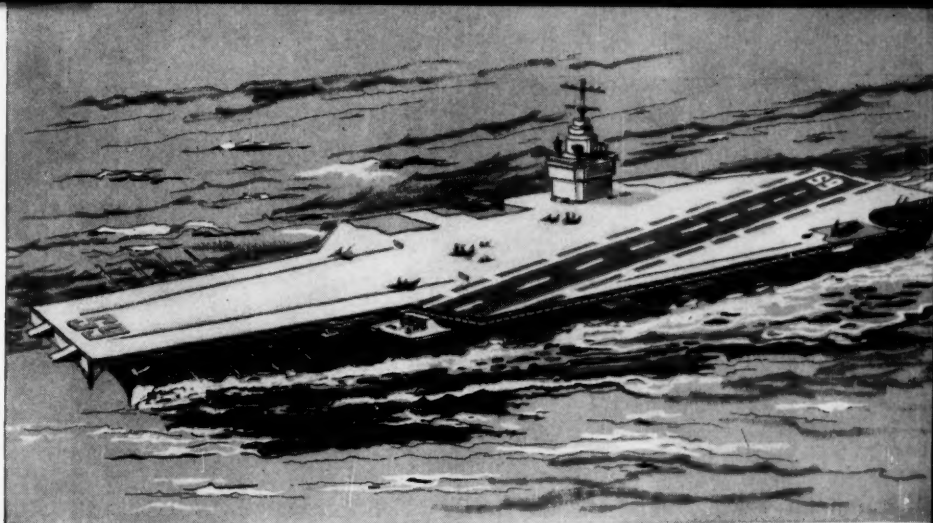
Next time you have a heating problem, remember...



N.S. Savannah—world's first nuclear-powered merchant vessel. Launched July 21, 1959.

U.S.S. Nautilus—world's first nuclear-powered submarine. Completed first transpolar voyage August 5, 1958.

Enterprise — world's first nuclear-powered aircraft carrier. Now under construction.



U.S.S. Skipjack—world's most maneuverable submarine. Sea trials completed March 10, 1959.

CHROMALOX Electric Heat *solved* heating problems for all these projects

Heaters are installed in the primary systems of pressurized-water-type nuclear reactors to maintain the desired pressure control. *Each of the nuclear power projects illustrated uses hundreds of special Chromalox electric cartridge type heaters for this purpose.*

Chromalox electric heaters handle many other heating jobs in these projects. On the Nautilus, for example, fourteen different types of Chromalox heaters are used . . . for such applications as comfort heating, de-icing, maintaining lubricating oil temperatures, purifying air and water and cooking food.

Chromalox was first to make electric heating practical. Today, Chromalox has the world's most complete electric heating line, the largest stock and a nationwide network of Sales Engineering Repre-

sentatives. Your Chromalox Man has the answers to *your* industrial, residential or commercial heating problems.

The Chromalox Library contains information on more than 15,000 different types, sizes and ratings of electric heaters and heating elements. Give us a brief outline of your problem and we will send you literature on heaters to do the job.





**these platinum
catalysts
simplify product
production control**

For highest levels of purity . . . definite economy and simplified, accurate production control, the platinum metals catalysts are unique. In the production of high-purity chemicals, pharmaceuticals, vitamins and biotics, their efficiency is unmatched by any other type of catalyst. Here, the world's largest facilities and broadest experience in the development and manufacture of platinum metals catalysts are at your service. A representative will be glad to confer with you, in strictest confidence, of course, or if you prefer, send for brochure "THE ROLE OF THE PLATINUM GROUP METALS AS CATALYSTS."

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**MINOXO
INDICATOR**



**SUPER-SENSITIVE
DEOXO INDICATOR . . .**

**for detection
and measurement
of oxygen or hydrogen
impurities in other gases**

MINOXO INDICATOR . . . measures traces of molecular oxygen in other gases—from 1 to 10 parts per million, and from 1 to 100 PPM. High sensitivity and rapid speed of response enable it to be used for laboratory investigation and production quality control.

SUPER-SENSITIVE DEOXO INDICATOR . . . measures oxygen or hydrogen present as impurities in other gases—from 2 to 200 parts per million oxygen and 4 to 400 parts per million hydrogen. Dual range permits measurement up to .25% oxygen or .50% hydrogen. Send for literature.

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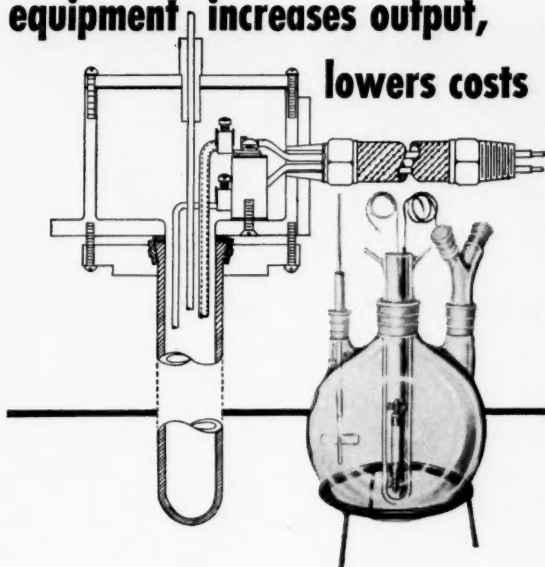
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**photosensitization processing
with Hanovia photochemical
equipment increases output,
lowers costs**



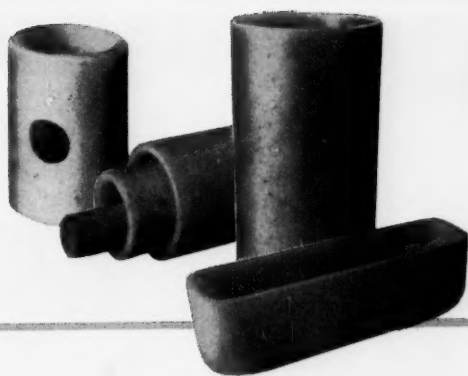
Hanovia photochemical equipment is widely used to increase output and lower costs in production involving synthesis, decomposition, hydrolysis, hydrogenation, oxidation, reduction, polymerization, bleaching, precipitation, isomeric change and halogenation. The Hanovia Laboratory Photochemical Reaction Equipment is a powerful suitable source for actinically sensitized reactions. It is excellent for testing actinic radiation processes to evolve and evaluate commercial actinically sensitized reaction techniques. Hanovia double-welled quartz or Vycor immersion wells fit standard 5 to 12 liter laboratory flasks. Permits maximum light utilization of mercury-vapor ultraviolet lamp, studies of admixture of reactants and temperature control. Write for valuable and informative brochure "PHOTOSENSITIZATION" for complete information on process and applications.

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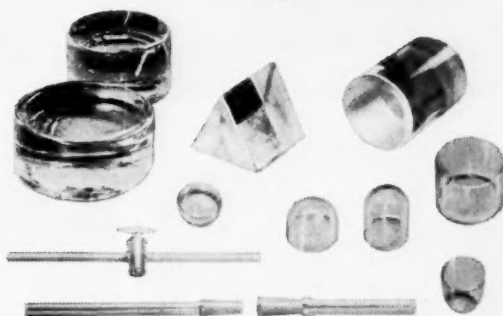
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**look to Amersil for all
high purity fused quartz
requirements.**



Amersil manufactures and fabricates high purity fused quartz for ultraviolet transmission applications, laboratory ware and production equipment. These products include standard apparatus, plain tubing in many intricate fabrications, crucibles, trays, cylindrical containers and piping in a full range of sizes up to 25" in diameter. Ingots and plates are available in general commercial quality as well as in special optical grades. Amersil engineers are also prepared to assist in developing fused quartz and silica equipment for special requirements. Send for bulletin.

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DIVISION

Giant Molecules



MAKING THE GIANT MOLECULES is increasing the demand for other products made by Republic. **ENDURO** Stainless Steel is the must metal in processing equipment because of its corrosion-resistance, heat-resistance, high strength, cleanability, inertness, long life, and low ultimate cost. In severe corrosive applications, Republic Titanium is ideally suited for valves, pumps, heat exchangers, pressure vessels. Republic SRK Plastic Pipe for chemical waste and process lines is providing substantial savings in material, installation, and replacement costs. It's highly resistant to a long list of corrosive liquids and gases. Mail coupon for more facts on these Republic products.



COAL CHEMICALS IN THE HOME add convenience, comfort, and pleasure. Refining of Tar permits its use in paints, roofing, and insulating materials. Naphthalene is familiar in the form of moth balls, but it is also important in making synthetic enamels that keep products new looking longer. Benzol is used in making plastics for housewares, floor tiles, shower curtains, synthetic-rubber bath mats . . . also in the manufacture of aspirin and antiseptics.

...for the Giant Consumer Market

The world is your market, and high polymer chemistry opens the door to new processes for the creation of new products to satisfy the hunger of this giant market.

Republic is vitally interested in this exciting new field of science. As an integrated steel maker, we are also a leading producer of high quality coal chemicals. Many of the basic chemicals used in making giant molecules come from the recuperative process of transforming coal to coke for our blast furnaces.

Republic Benzols, Toluols, Tar, Pyridine, Crude Naphthalene, Xylols, and Crude-Heavy Solvent are currently being used in the manufacture of thousands of products. Sulphate of Ammonia, in mixed and blended fertilizers, forms an industry in itself. Yet the surface has only been scratched. Of the nearly 2000 chemicals available from coal, only a small percentage have found their way into commercial use.

Concurrent with the work of polymer chemists in developing processes to speed the creation of new products and reduce the cost of present ones, Republic's own chemists are actively engaged in a program of coal chemical research. This program will enable Republic to keep pace in the rapidly growing field of giant molecules and to continue as a dependable source of supply for high quality, high purity coal chemicals.

Which of the Republic Coal Chemicals described at right and below can you use in your product or process to satisfy the giant consumer market?

COAL CHEMICALS ON THE FARM. Strong, healthy cattle reach marketable size faster. Xylols produced by Republic are used in the manufacture of germicides to protect livestock from germs and microorganisms. Ruined and farmed-out land is restored with the help of Sulphate of Ammonia in mixed and blended fertilizers. Benzol is a basic material in the production of agricultural chemicals designed to control pests, weeds, and plant diseases.



THE GIANT CONSUMER MARKET reveals countless applications of Republic Coal Chemicals. Benzol is used in dyes for coloring cloth and fabric, in many types of wearing apparel, like nylon stockings, in synthetics for super-tough suitcases. It is also used in soaps and detergents. Perfumes are derived from Toluols. Pharmaceuticals are made from Pyridine. Xylols are basic in making riboflavin. Crude Heavy Solvents are used in water-proofing compounds and for stiffening leather.



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*World's Widest Range
of Standard Steels and
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REPUBLIC STEEL CORPORATION

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Send more information on:

- ☐ ENDURO® Stainless Steel
☐ Titanium ☐ SRK Plastic Pipe

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____



Fred Wheelwright,
Manager, Industrial Sales:

"The profit derived from a process is directly dependent on the efficiency of the processing equipment. Here, at De Laval, we specialize in bringing maximum efficiency to the chemical processor.

"We go at it with a triple punch: an outstanding engineering staff; the most complete processing pilot plant in the country; and a full line of efficiency-engineered process equipment.

"The case of the detergent manufacturer cited in this advertisement is an example of our work in helping processors develop profitable processing operations. Without the specified, high efficiency centrifuge, this process might well have proved impractical because of the production costs.

"Why not let us devote our facilities and engineering talent to *your* problems. Just drop us a line on your letterhead describing your process.

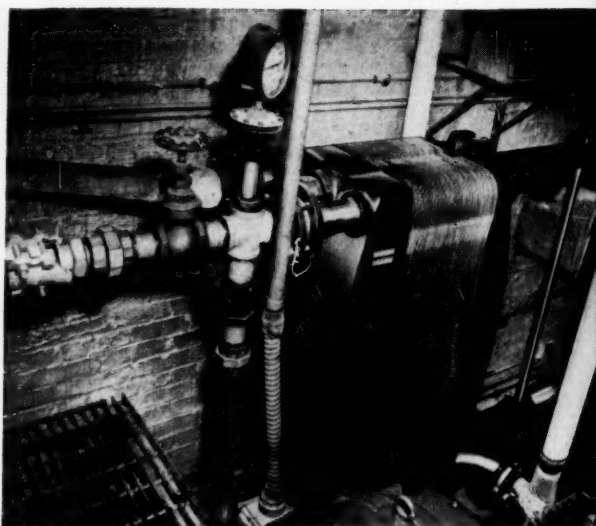
We'll be glad to recommend ways to increase your processing efficiencies. And, of course, there is no obligation to you."

For further information, write to De Laval.



THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York
5724 N. Pulaski, Chicago 46, Illinois

DE LAVAL PACIFIC COMPANY
201 E. Millbrae Avenue, Millbrae, California



THREE SOLVED WITH

TDM* classification of silica increased plant production 100%

Problem: To accurately classify five grades of silica as the last processing step before packaging and warehousing. Bottlenecking at this point had cut plant production.

Solution: A system of De Laval Syncro-Matic Separators with TDM Control. On leaving the dryer, silica was fed to the Primary screening unit which handled 11.3 tons per hour at efficiencies of better than 95%. The Secondary screener picked up the balance of the silica, handling 4 tons per hour, also at efficiencies of better than 95% on each grade.

By using De Laval Syncro-Matic Separators with TDM Control in this application, plant production was increased a full 100%.

*TDM... *three directional motion control.* The Syncro-Matic has motion controlled in all three directions... horizontal, vertical and gyratory. It's the secret of the unit's outstanding efficiencies, and it is also responsible for the far greater throughput possible with the machine.

Available in carbon or stainless steel, the Syncro-Matic may be obtained with from one to three decks, and a full range of screen meshes and materials. Operation of the unit is exceptionally quiet.

For further information about this versatile new screen separator, just drop us a line on your letterhead. No obligation, of course.



Downtime for cleaning cut over-all efficiencies in Shell & Tube shellac cooling

In refining shellac to remove wax (a valuable by-product), the solution of shellac and soda ash must be heated to 200°F. After the wax is removed, the solution must be cooled rapidly. The processor had been using a Shell & Tube exchanger, but down-time for cleaning, and a series of cloggings and leakages had made serious cuts in processing efficiency.

Problem: To cool 13,500 lbs. per hour of the shellac/soda ash solution from 200°F. to 70°F. The efficiency of the

operation is of prime importance because the processor does not have an abundant water supply.

Solution: A single section De Laval P-12 Plate Heat Exchanger. The unit requires only 12,600 lbs. per hour of 60°F. water and maintains a temperature differential of 10°F. The plate heat exchanger cools the shellac/soda ash solution both rapidly and with the most efficient use of the available water supply.

The ease of cleaning the De Laval Plate Heat Exchanger is important to the processor, too. The plate pack is easily opened, immediately exposing all heat transfer surfaces for thorough, rapid, manual cleaning. Constructed of

stainless steel throughout, it is easier to clean and eliminates problems of contamination in operation.

Note in the illustration how compact the unit is. It easily fits into available plant space, required no additional construction. And since this unit has been installed, the processor reports complete elimination of problems due to clogging or leakage.

If your process could benefit from the top efficiencies, maximum temperature control, and higher capacities of the De Laval Plate Heat Exchanger, why not drop us a line requesting more information? There's no obligation to you, and it may well prove the answer to some of your processing problems.

EFFICIENCY PROBLEMS... DE LAVAL PROCESS EQUIPMENT

CENTRIFUGES • PLATE HEAT EXCHANGERS • VIBRATING SCREENS • COMPLETE PROCESSES

Processor of new detergent cleaned up recovery problem with fast, non-stop separator

Problem: A processor developing a new detergent made from vegetable oil needed an efficient method of recovering the expensive catalyst in re-usable form. Previous attempts had recovered non-dispersible catalyst in a hard cake form.

Solution: A De Laval AC-VO "Nozzle-Matic" Centrifuge. Since the heavy phase in the separation (containing the catalyst) is thrown to the bowl wall and discharged *continuously* as part of the machine's normal operation, the catalyst is recovered in a thick slurry. In this form, it is easily re-dispersed.

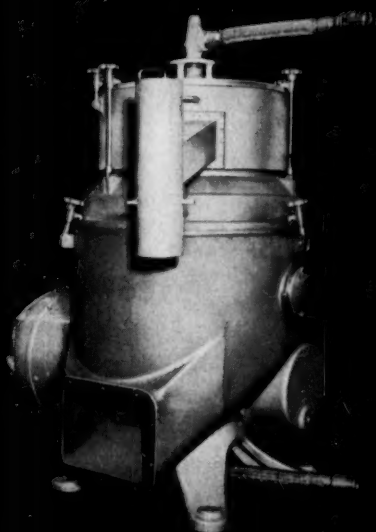
This particular unit was also supplied with a heavy phase recirculation feature. As the heavy phase is dis-

charged through the nozzles built into the bowl wall, it is picked up and recirculated to the centrifuge bowl. The result is a higher concentration of the catalyst, and in a state of maximum clarification.

The higher capacities possible with De Laval continuous discharge centrifuges were important to this processor, too. Combined with the fast operation, they insured maximum catalyst life. Slow operation had been a factor in the hard caking of the catalyst in previous attempts at recovery.

Wherever recovery of a solid is important in your process, you should consider the different types of solids concentrators we make at De Laval. There is a type for every recovery operation.

Why not drop us a line for further information? Just tell us the type of recovery which interests you. There is no obligation, of course.





PROBLEM: When an oil-well drill passes through a heaving shale formation, shale and clay particles get into the drilling mud, causing it to thicken. Yet the viscosity of the mud must be kept low.

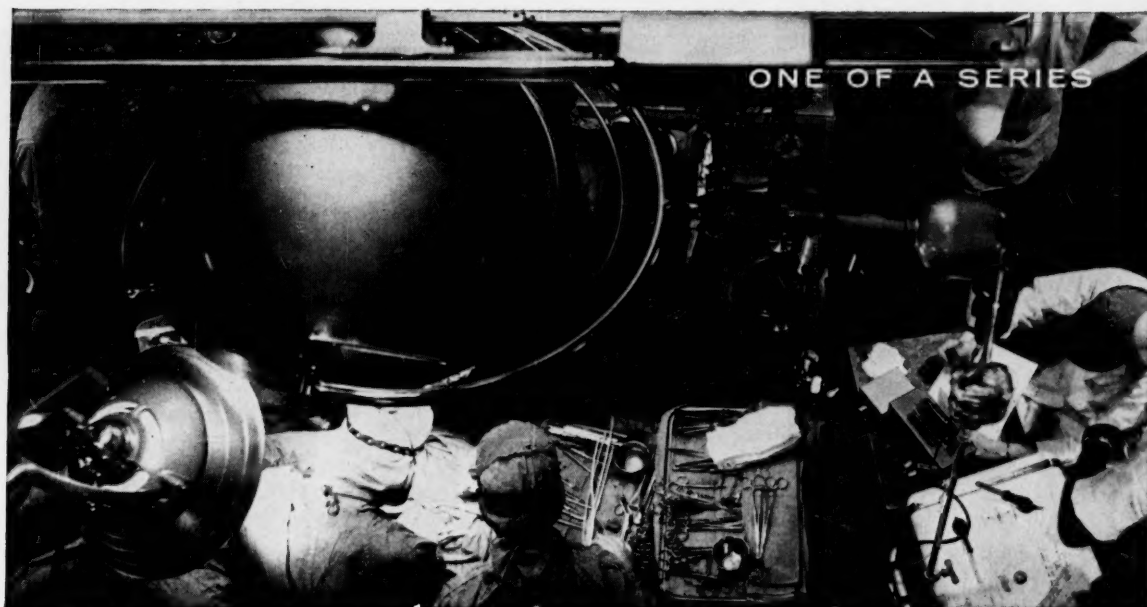
SOLUTION: The addition of Pluronic L61 or L62 to the drilling mud effectively controls the viscosity. The increased penetration and decreased bit wear result in cheaper and faster holes.

Can Pluronic® polyols give



PROBLEM: Rayon cords must have great strength—and they do. Nevertheless, the rayon industry is constantly seeking to make tire cords even stronger and safer—for lives hang in the balance.

SOLUTION: Formulators have found that treating tire-cord grade cellulose pulp with a Pluronic polyol increases strength without cratering, helps prevent clogging of the spinnerette.



PROBLEM: During operations, a mechanical heart is sometimes used to function for the patient's heart and lungs. But the blood it pumps tends to foam, admitting bubbles into the bloodstream.

SOLUTION: Silicones effectively eliminate the foam, but they must be emulsified before use. Pluronic F-68 was chosen for this job because it has an unusually low order of toxicity.

your product new functions?

SOMETIMES these versatile chemicals can broaden the application of a product by eliminating an undesirable property, or by adding a desirable one. Some reasons:

The Pluronic polyols are a series of patented block-polymers that exhibit a wide variety of surface-active properties. The various grades range in physical form from mobile liquids and pastes to solids sufficiently hard to be flaked . . . all grades are 100% active.

The series has a molecular weight range of 1000 to over 11,000. The grades vary from materials that are almost water insoluble to materials that have no cloud point—even at the boiling point of water.

These pictures show three typical uses of the Pluronic polyols. Actually, over 100 different applications have been found so far, and the end is not in sight!

Chances are one or more of these properties could be used to advantage in either your present product or the new one you're developing. For samples, technical data, and your copy of the Pluronic Grid, why not write us today? *Wyandotte Chemicals Corp., Dept. 784-E, Wyandotte, Mich. Offices in principal cities.*



The famous Pluronic Grid provides a controlled, systematic method of product screening . . . minimizes costly random investigation and evaluation by establishing related property trends among the grades available.

Wyandotte CHEMICALS

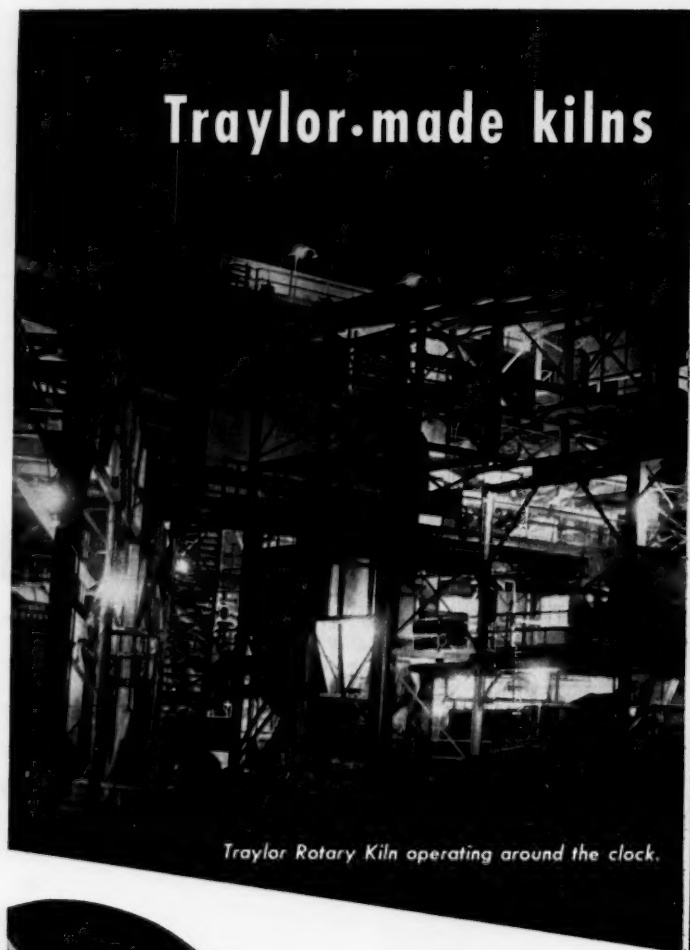
MICHIGAN ALKALI DIVISION
Pacing progress with creative chemistry

SODA ASH • CAUSTIC SODA • BICARBONATE OF SODA • CALCIUM CARBONATE • CALCIUM CHLORIDE • CHLORINE • MURIATIC ACID • HYDROGEN • DRY ICE
GLYCOLS • SYNTHETIC DETERGENTS • SODIUM CMC • ETHYLENE OXIDE • ETHYLENE DICHLORIDE • POLYETHYLENE GLYCOL • PROPYLENE OXIDE
PROPYLENE DICHLORIDE • POLYPROPYLENE GLYCOL • DICHLORODIMETHYLHYDANTOIN • CHLORINATED SOLVENTS • OTHER ORGANIC AND INORGANIC CHEMICALS

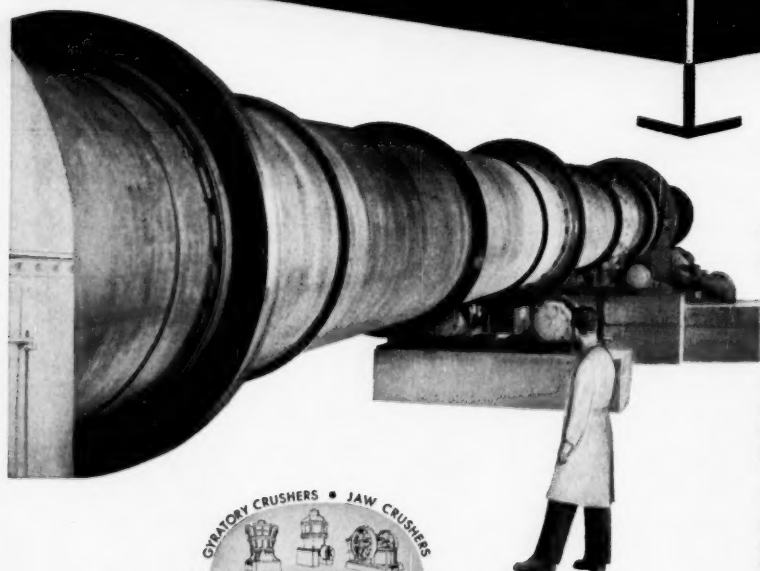
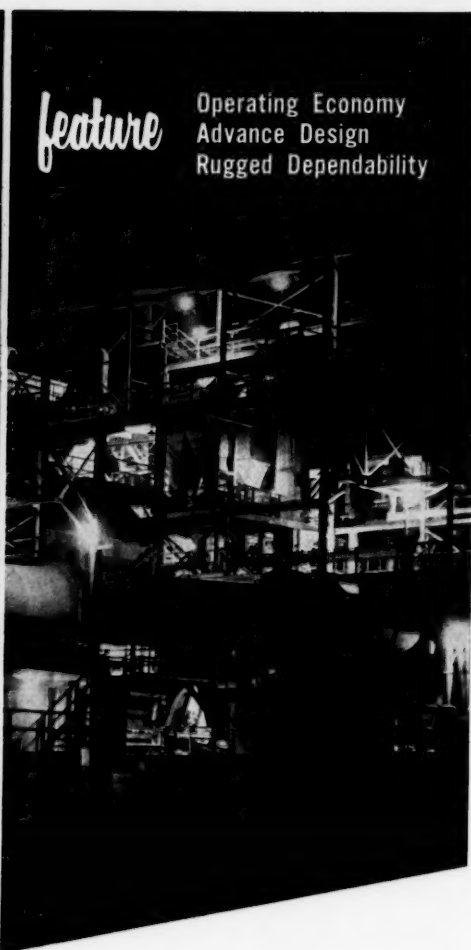
Traylor-made kilns

feature

Operating Economy
Advance Design
Rugged Dependability

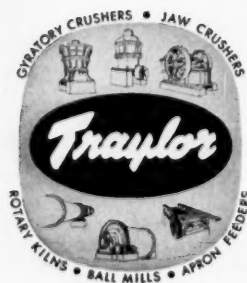


Traylor Rotary Kiln operating around the clock.



Traylor Rotary Kiln showing riding rings and thrust roller mechanism.

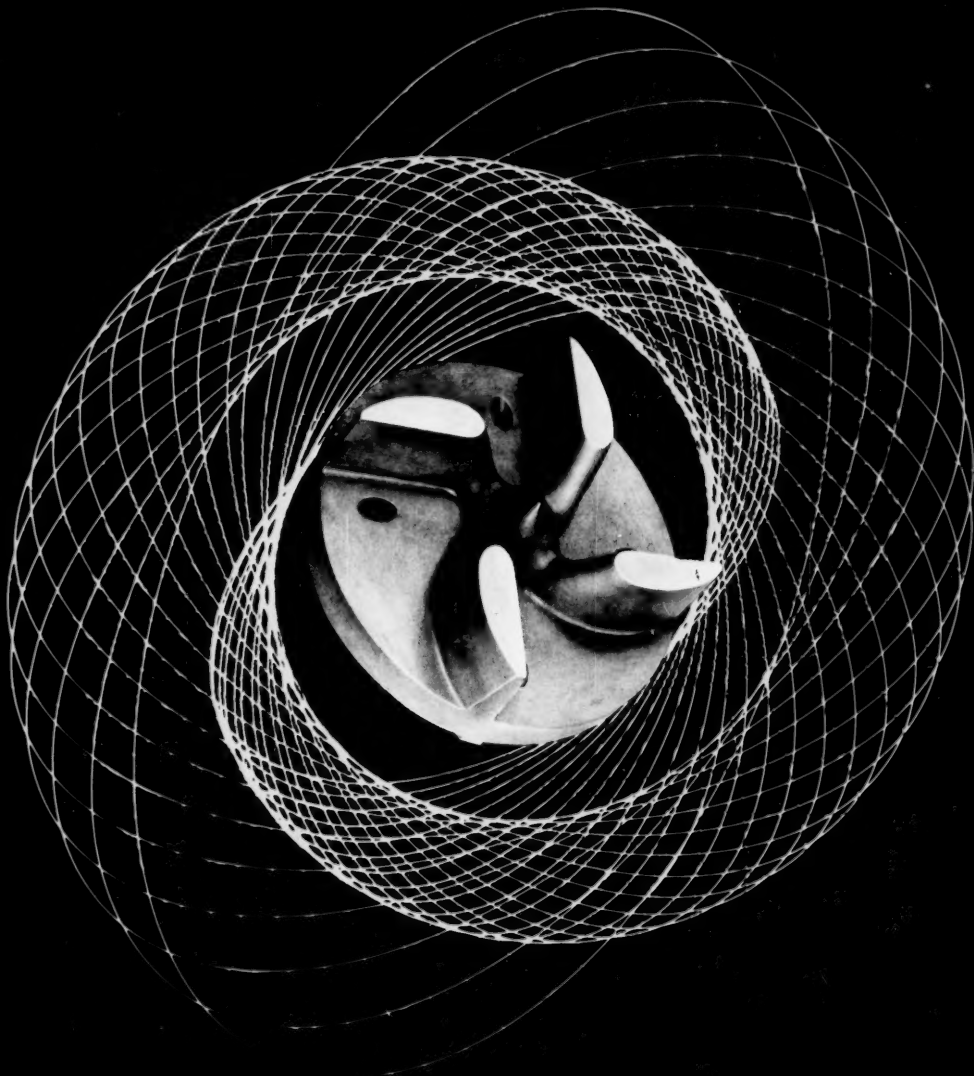
Traylor is the recognized leader in designing and building rugged dependable Rotary Kilns. From the quality steel plate of the kiln shell and the "full-floating" type of roller ring to the drives and firehood — Traylor guarantees a satisfied customer. For more on Traylor Kilns, Coolers and Slakers write for Bulletin No. 1115.



TRAYLOR ENGINEERING & MFG. CO., 1400 MILL ST., ALLENTOWN, PA.

Sales Offices: New York — Chicago — San Francisco

Canadian Mfr.: Canadian Vickers, Ltd., Montreal, P. Q.



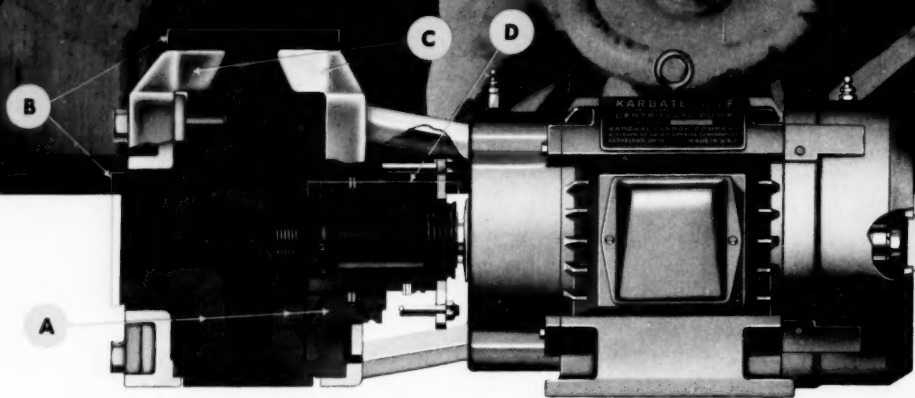
YOU CAN PAY MORE...
BUT YOU CAN'T BUY
A BETTER CORROSION RESISTANT PUMP



KARBATE

TRADE-MARK

IMPERVIOUS GRAPHITE ECONOMICAL...AND UNSURPASSED IN

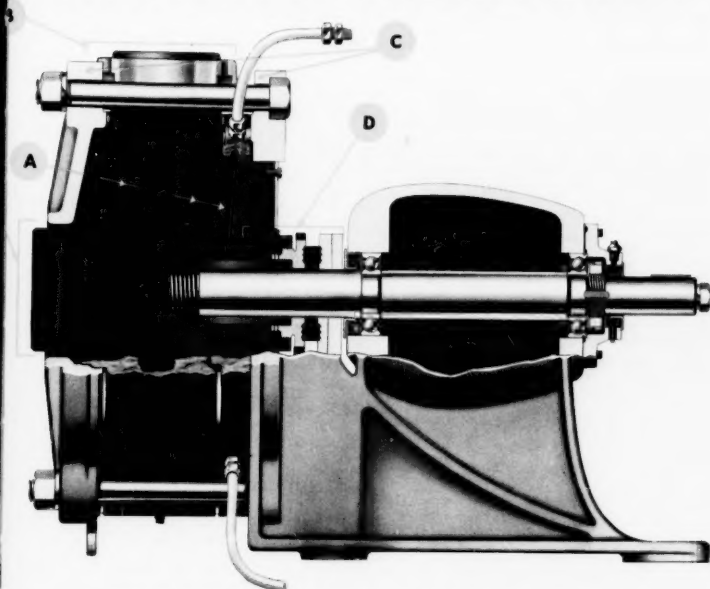


TYPE F MOTOR-MOUNTED CENTRIFUGAL PUMP

Cross-section above illustrates typical "Karbate" motor-mounted pump recommended for heads to 70 feet—capacities to 140 gpm. Letters refer to component features common to every "Karbate" pump.

- A—Rugged "Karbate" impervious graphite wet-end parts
- B—Compression type connections
- C—Cast steel armoring
- D—NATIONAL CARBON'S rotary seal arrangement

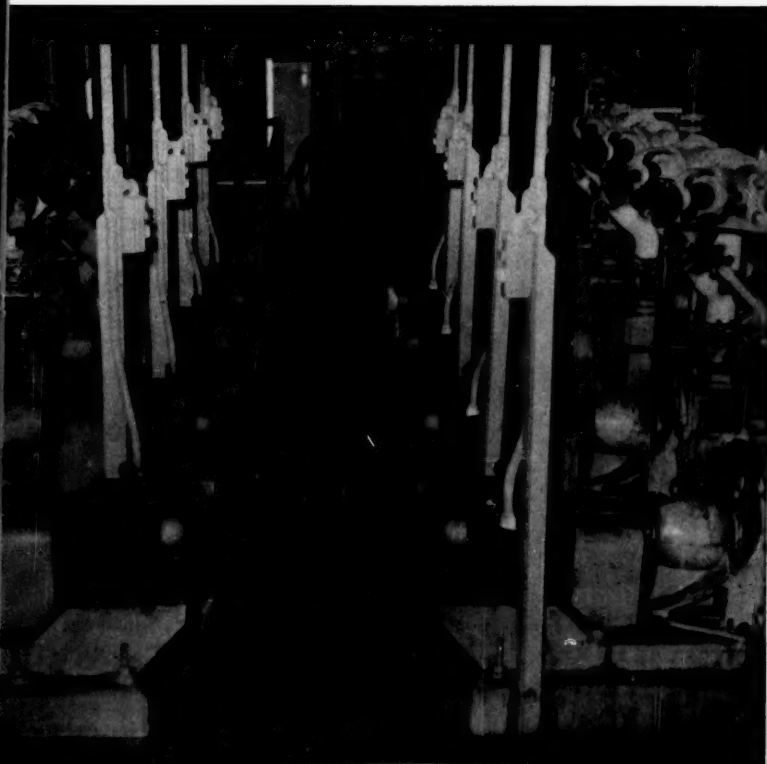
PUMPS ARE RUGGED... CORROSION RESISTANCE!



TYPE C FRAME-MOUNTED CENTRIFUGAL PUMP

Cross-section shows typical "Karbate" frame-mounted pump recommended for heads to 120 feet—capacities to 1500 gpm. Adaptable to motors, belt drives or steam turbines.

- A—Rugged "Karbate" impervious graphite wet-end parts
- B—Compression type connections
- C—Cast steel armoring
- D—NATIONAL CARBON'S rotary seal arrangement



7 reasons why it will pay you to standardize on "KARBATE" Pumps

1 RUGGED CONSTRUCTION

All component parts are designed structurally to withstand normal—and many abnormal—conditions which occur in pumping and maintenance operations. The cast steel armoring and compression type connections help prevent damage from externally caused shocks and stresses.

2 UNSURPASSED CORROSION RESISTANCE

Few other pumps—regardless of price—can handle as wide a variety of corrosives as "Karbate" impervious graphite pumps. They are resistant to: **mineral acids** such as hydrochloric, sulfuric, phosphoric; **acid combinations** such as nitric-hydrofluoric, phosphoric-sulfuric; **chlorinated hydrocarbons**; **alkalies**; and **organic and inorganic compounds** of all types. In practically all of these corrosives, changes in temperature and concentration will not affect the corrosion resistance of "Karbate" impervious graphite.

3 WIDE RANGE OF MODELS AND SIZES

Twenty-five standard sizes of "Karbate" centrifugal pumps are available in both motor-mounted and frame-mounted types with capacities from 5 to 1500 gpm and heads from 15 to 120 feet. Motor-mounted pumps can be supplied with 1, 1½, 2, 3 and 5 horsepower motors. Frame-mounted pumps can accommodate motors up to 60 horsepower and can be adapted to belt drives or direct-coupled to steam turbines. Pumps can be operated at speeds up to 2400 rpm.

4 READY AVAILABILITY

All standard sizes and models of pumps and a large inventory of replacement parts are carried in stock for immediate shipment. In emergencies, parts can be shipped the same day order is received.

5 PARTS ARE INTERCHANGEABLE

"Karbate" centrifugal pumps are designed for maximum interchange of parts. This keeps replacement parts stock at a minimum. All parts from the case cover back to the motor or frame are interchangeable within any model group. Impervious graphite is easy to machine. This makes possible the field turn-down of impellers to fit changed operating conditions.

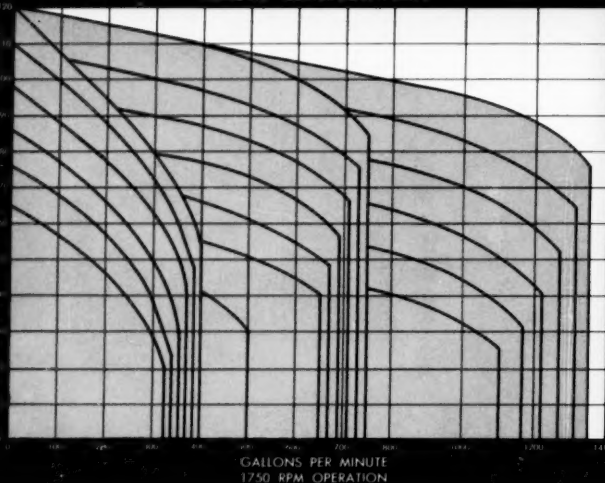
6 CHOICE OF SHAFT SEALING ARRANGEMENTS

NATIONAL CARBON'S rotary seal is standard on all "Karbate" centrifugal pumps. Pumps can also be furnished with "Durametallic", "John Crane" or "Chemiseal" rotary seal arrangements or stuffing boxes with external lubrication.

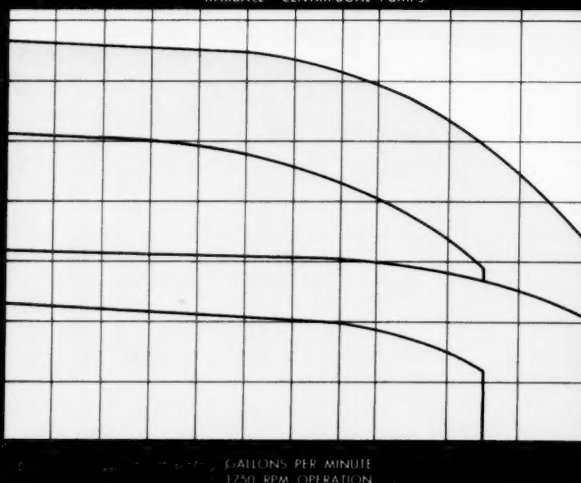
7 LOW OVERALL COST

The corrosion resistance of impervious graphite and the rugged construction of "Karbate" centrifugal pumps keep maintenance costs at a minimum. Furthermore, the initial cost of a "Karbate" pump is usually significantly less than that of a pump with equivalent corrosion resistance.

APPROXIMATE CAPACITY RANGES
STANDARD FRAME MOUNTED MODELS
KARBATE CENTRIFUGAL PUMPS



APPROXIMATE CAPACITY RANGES
STANDARD MOTOR MOUNTED MODELS
KARBATE CENTRIFUGAL PUMPS



CAPACITY RANGES OF "KARBATE" CENTRIFUGAL PUMPS

These charts show the approximate head and capacity ranges of "Karbate" pumps. The lines on the charts are characteristic of the individual standard models. In the frame-mounted type C pump, higher capacities and heads can be obtained by increasing speeds to a maximum of 2400 rpm.

NATIONAL CARBON'S FIELD ENGINEERS WILL HELP YOU USE "KARBATE" PUMPS

NATIONAL CARBON'S eight field engineers call daily on the chemical and allied industries throughout the country. They are qualified and experienced to recommend the best corrosion resistant pump for your specific installation.

In addition, they will be glad to demonstrate to your production and maintenance departments the installation, operation and maintenance practices for "Karbate" impervious graphite centrifugal pumps.



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Tel. FI 6-3300
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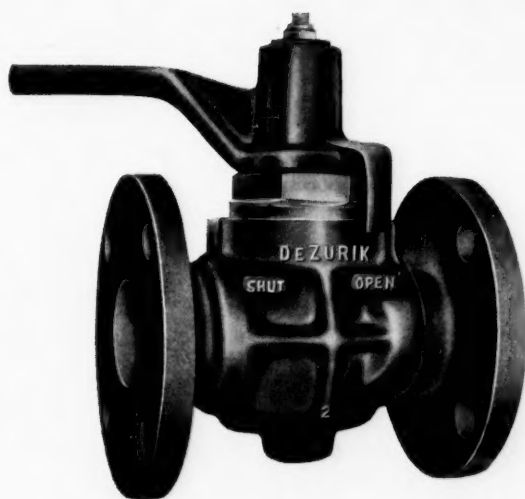
NATIONAL CARBON COMPANY • Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.

SALES OFFICES: Birmingham, Chicago, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco • IN CANADA: Union Carbide Canada Limited, Toronto
Litho in U. S. A.



DeZurik

PLASTIC-COATED VALVES



DeZurik Eccentric Valves can now be furnished with plastic coatings. With plastic coatings, the corrosion resistance of a cast iron valve is greatly increased at only a slight increase in price.

DeZurik Plastic-Coated Valves are the economical answer to valving alkalis, mild acids, sea water and other neutral salts. They are also particularly suitable for de-ionized and de-mineralized water where iron contamination is objectionable.

Coated or uncoated, DeZurik Eccentric Valves can provide the positive answer to your valving problems.

*For more information,
contact the DeZurik representative in your area,
or write Dept. PC.*

 **DeZURIK**
CORPORATION
SARTELL, MINNESOTA

ANOTHER IN A SERIES
OF MOTOR FACTS
FROM ALL INDUSTRIES



Sand... heavy rain... extreme heat...

Nothing stops These Westinghouse *Life-Line A* Motors

*dependably driving oil well pumps in Odessa, Texas
district of The Atlantic Refining Company,
24 hours per day, 7 days a week!*

"Here's an application," says A. P. Johnston, production engineer at The Atlantic Refining Company, "where we must have continuous motor operation . . . sometimes for as long as 18 months . . . with virtually no maintenance or repair. Many of our pumping stations are remotely located, automatic and unmanned. Any stoppage or motor failure would result in the loss of several hundred barrels of oil. Motor repairs in the field are prohibitive in cost. We must have *complete* motor reliability and that's

exactly what we get from our Westinghouse Life-Line® "A" motors."

How about you? Got a really tough motor application which you can't afford to pamper? Then ask your Westinghouse sales engineer to show you how the dependable Life-Line "A" pays for itself through reduced maintenance and repair. Or write to Westinghouse Electric Corp., P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

J-22055-R

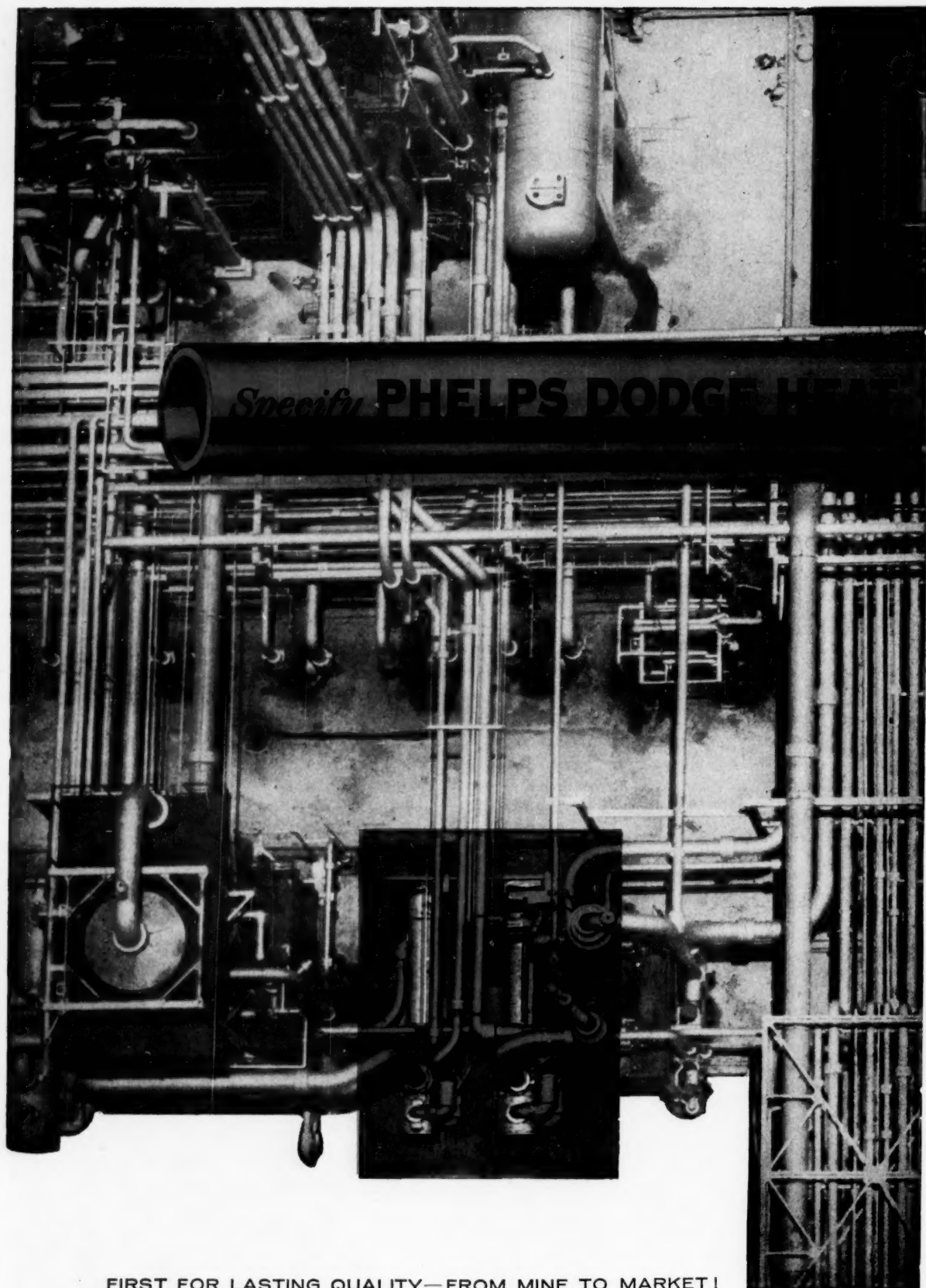
YOU CAN BE SURE... IF IT'S

Westinghouse



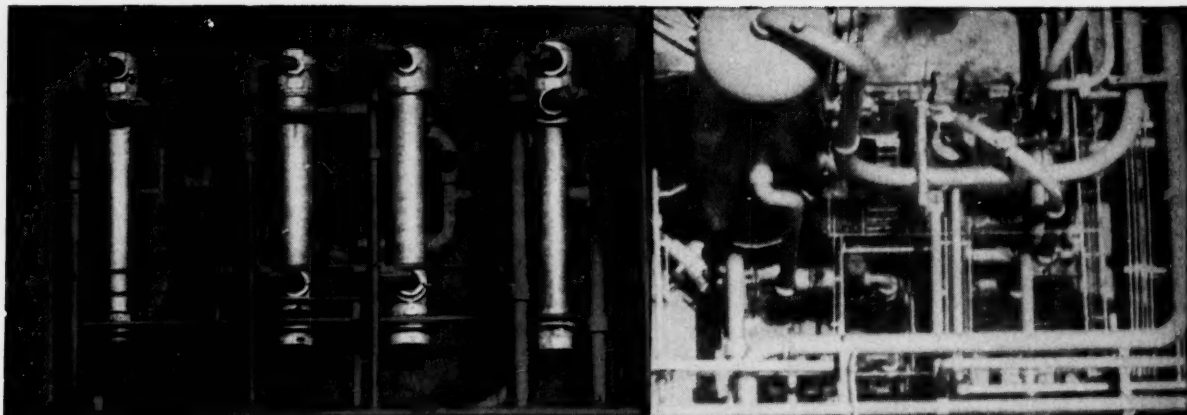
On this pumping unit, the 15-hp Life-Line "A" motor operates in an atmosphere of damaging dust, sand and moisture. Despite continuous, heavy-duty service, motor has never suffered any overheating since first installed. Prelubricated bearings of the Life-Line "A" eliminate periodic greasing . . . keep lubricant in . . . dirt out.





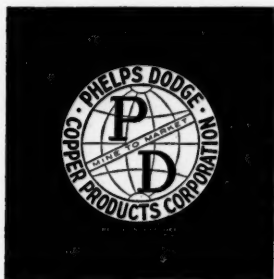
Specify **PHELPS DODGE HEAT**

FIRST FOR LASTING QUALITY—FROM MINE TO MARKET!



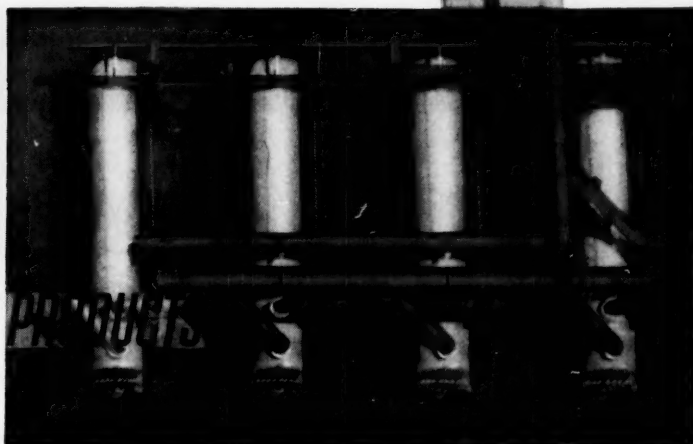
EXCHANGER TUBES *for Longer Service*

- Full range of copper-base alloys for every application.
- Vast background of application engineering to assist in proper alloy selection.
- Complete control of quality throughout every step of manufacture.



PHELPS DODGE COPPER PRODUCTS CORPORATION

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THE COOPER-BESSEMER CORPORATION
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Edmund S. Budd, *Manager of Parts Division,*
The Cooper-Bessemer Corporation, points out that...

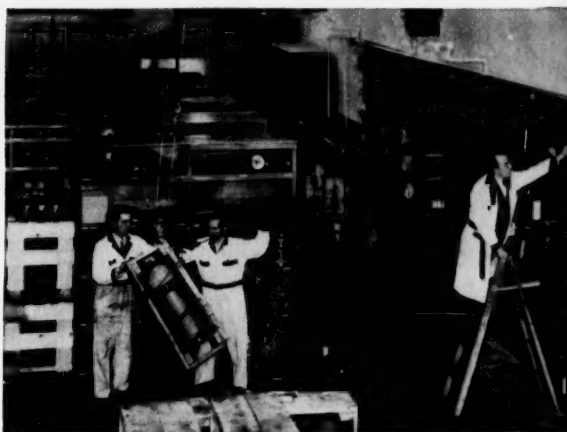
**You are this near to
Cooper-Bessemer service!**



Experienced Cooper-Bessemer field technicians assist you in installation and servicing of equipment.



Cooper-Bessemer engineers are ready to assist you in planning power or compression facilities, or solving operating problems.



Cooper-Bessemer warehouses, strategically located, provide replacement parts for speedy servicing and peak availability of your facilities.

WHEN YOU INVEST in Cooper-Bessemer engines, compressors or controls, our service facilities are as close to you as the telephone... night and day! We serve you in these three important ways:

Technician service. Our skilled installation and maintenance crews are permanently located in areas throughout the country, ready to assist you, to assure top economy of operation and availability of your Cooper-Bessemer equipment.

Warehouse service. We maintain an extensive inventory of replacement parts for Cooper-Bessemer products in strategic locations to give prompt attention to your needs.

Engineering service. As new or changed conditions arise, our experienced field service engineers can give you on-the-spot recommendations. And they are backed up by the strong team of Cooper-Bessemer engine and compressor engineers in Mount Vernon.

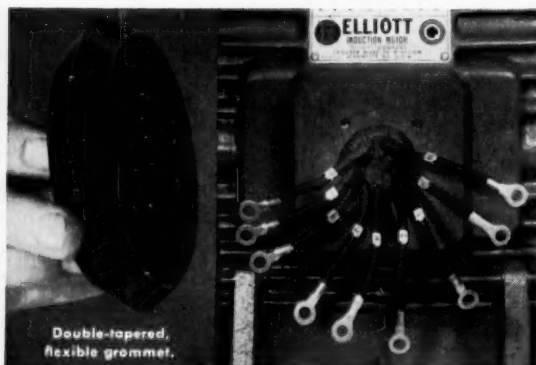
The superiority of Cooper-Bessemer Service can save you thousands of dollars yearly in capital investment and in operating cost. Make sure you take this important *plus value* into account when you specify and buy engine and compressor facilities.

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Gloucester • Chicago • Minneapolis • St. Louis • Kansas City • Tulsa
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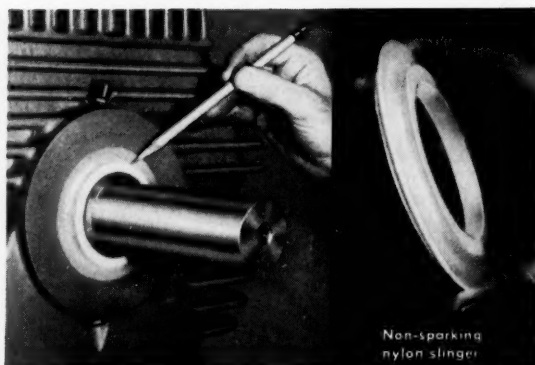
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ENGINE OR MOTOR DRIVEN

better protection and better cooling make Elliott C-W SEALEDPOWER MOTORS outstandingly



TIGHTLY COMPRESSED GROMMET seals leads where they leave motor frame. Grommet is compressed around numbered leads by pressure ring. No leakage here.

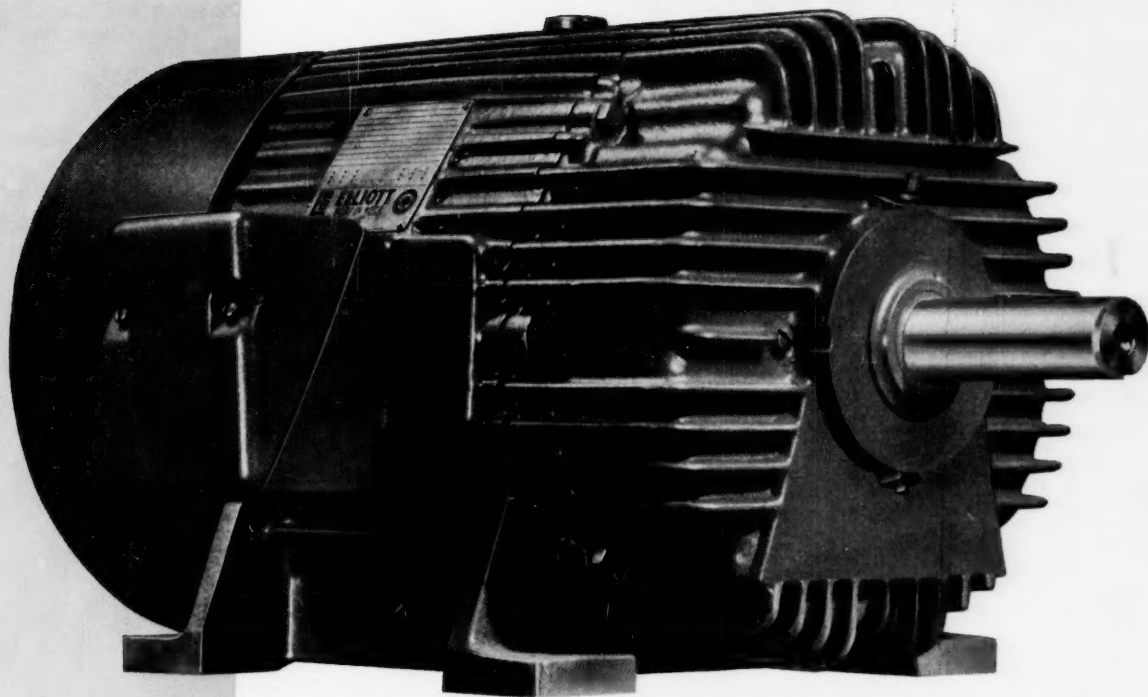


ROTATING SLINGER BANISHES MOISTURE, DIRT that otherwise might creep along shaft and through bearing. Recessed into bracket, it provides long labyrinth-type seal.

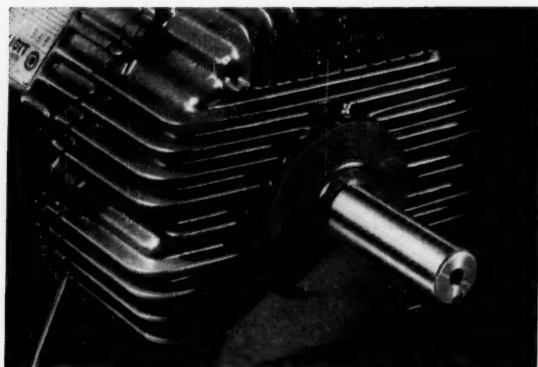
IMPORTANT FACTS
about enclosed motors are given in
new Elliott Bulletin PB-6000-2.
Send for free copy today.



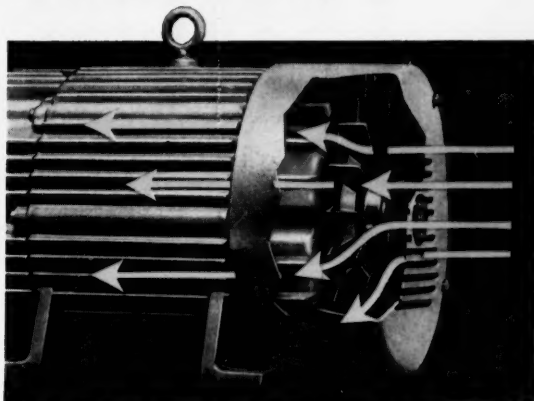
Elliott C-W ribbed-frame enclosed motors, pioneered in the United States by Crocker-Wheeler, include ratings up to 300 hp.



dependable!



MORE AND DEEPER HEAT-RADIATING FINS have greater cooling area. Generous fins over rear bracket keep bearing cool. Non-clogging, easy to clean.



COOLING AIR BLAST FROM EXTERNAL FAN, directed by fan cowl, hugs entire length of motor. Non-sparking fan has keyed and clamped split hub.



ELLIOTT Company


CROCKER-WHEELER PLANT • JEANNETTE, PA.

W9-1



HERE'S WHY:

Light weight—weighs only $\frac{1}{3}$ as much as steel . . . easier to handle regardless of the job . . . easy to cut, bend and thread, and without special tools . . . competitive in price for initial savings as well as future savings . . . corrosion resistance means no maintenance under normal service conditions . . . non-sparking for safer installations . . . no special nonsparking tools required . . . nonmagnetic properties mean less voltage drop . . . good appearance that lasts and lasts . . . color coded for fast, accurate size identification. Approved by Underwriters' Laboratories, Inc. . . and it's available from local distributor stocks for fast, dependable delivery.



ALUMINUM CONDUIT JOBS GO UP FASTER

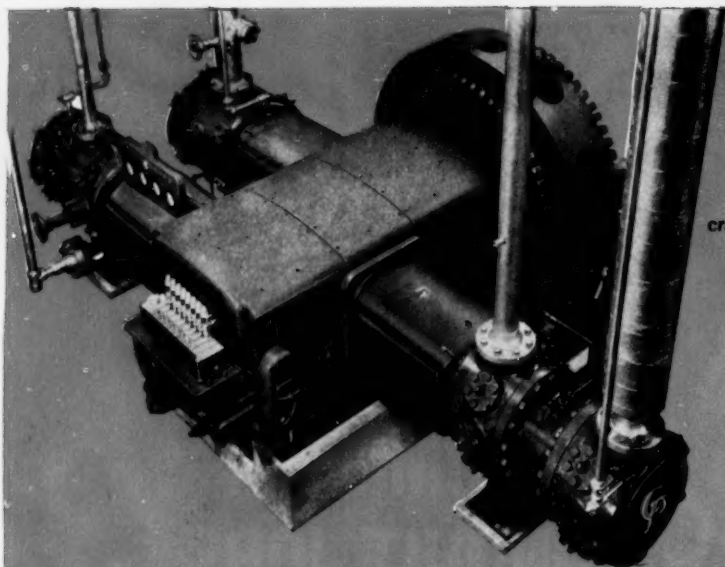
Aluminum conduit not only makes jobs go up easier, faster and therefore more profitably, but also helps give you a higher quality, longer lasting installation. Why not use aluminum conduit on your next job? Start enjoying all the many advantages which only timesaving, costsaving aluminum conduit can provide. Your local Alcoa or Rome distributor can give you all the facts and figures for any particular installation. Or, write to Rome Cable Division of Alcoa, 2147-M Alcoa Bldg., Pittsburgh 19, Pa.

ROME CABLE DIVISION OF **ALCOA**

Your Guide to the Best in Aluminum Value

For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and the Emmy Award winning "Alcoa Theatre" alternate Mondays, NBC-TV

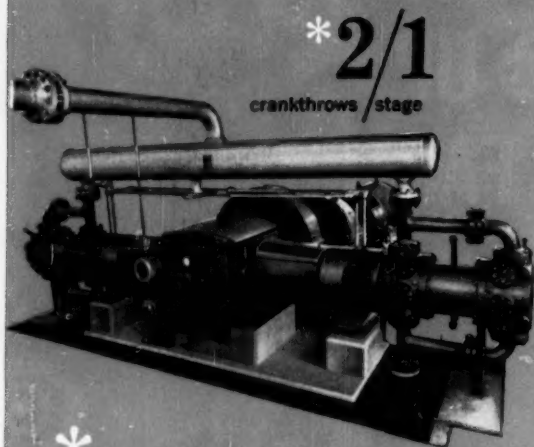




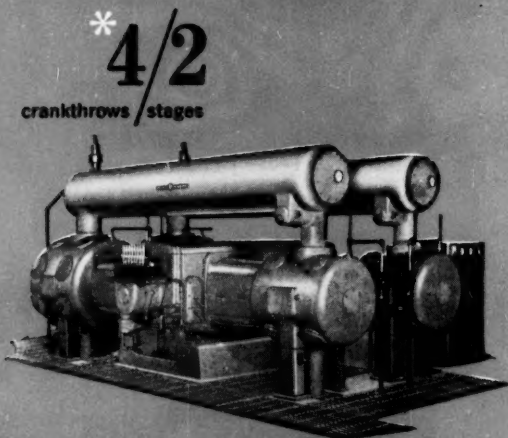
* **3/3**
crankthrows / stages



* **6/2**
crankthrows / stages



* **2/1**
crankthrows / stage



* **4/2**
crankthrows / stages



Typical of the many combinations of compressor crankthrows, cylinder arrangements and staging that give you the perfect compressor for every process requirement.

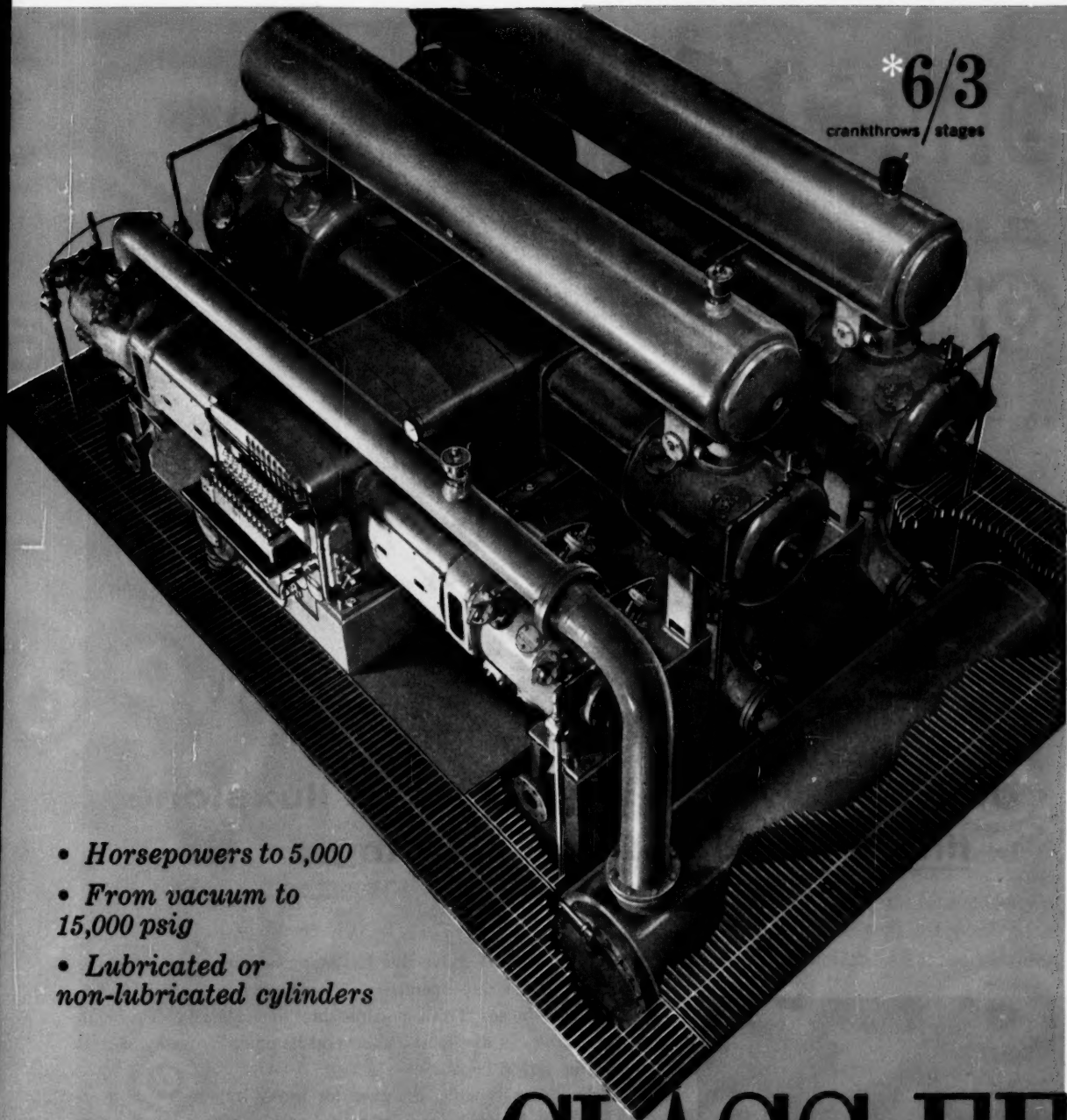
ADAPTABILITY...



Chicago Pneumatic

8 East 44th Street, New York 17, N. Y.

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS



*6/3

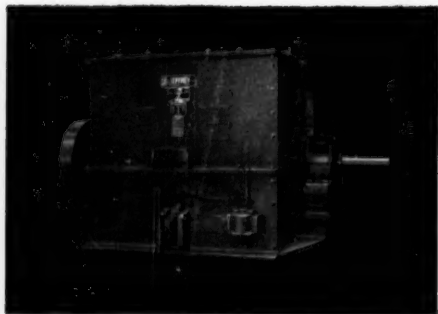
crankthrows / stages

- Horsepowers to 5,000
- From vacuum to 15,000 psig
- Lubricated or non-lubricated cylinders

at its best in CLASS FE COMPRESSORS



Jeffrey Pulverizer fine for efficient crushing fluxstone sintering



The Jeffrey Type B Pulverizer has many advantages in crushing fluxstone for sintering operations. It crushes *fine*—standard $\frac{3}{8}$ ", or $\frac{1}{8}$ ", when required. This is possible since the material goes through several changes in direction and several hammer contacts before it reaches the screen bars.

This unit is reversible, designed for heavy duty work, is dust-tight, and has hydraulic adjustments. Power requirements are less than with other units, since most of the work on the material is done before the material reaches the screen bars.

Fluxstone is but one of hundreds of materials which can be efficiently reduced with Jeffrey Crushers...from alum and asbestos to rock and slag. For complete information check your nearest Jeffrey sales engineer. The Jeffrey Manufacturing Company, 909 North Fourth Street, Columbus 16, Ohio.



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**CAN BE SIMPLE,
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Perhaps you've felt the need to meter your industrial liquids but have hesitated because you feared metering was costly or complicated. Actually, even a plant-wide installation of simple, direct reading Rockwell meters can be made very easily and for a nominal investment. They will pay their way many times over by providing realistic records for cost, inventory and utilization controls.

Measure Even Corrosive Liquids. Among the many types of Rockwell meters, there is the right design to measure most anything that flows . . . including *all stainless-steel meters* for corrosive liquids.

If you blend, batch or package liquids, Rockwell meter accessories such as automatic shut-off controls, impulse counters and remote registration will cut your costs and increase production. Use the coupon for full details.

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I am interested in measuring _____
(Name of Liquid)

Pipe Size _____

Working Pressure _____ psi Temperature _____ °F max.

Max. Flow Rate _____ gpm Min. Flow Rate _____ gpm

Your Name _____

Company _____

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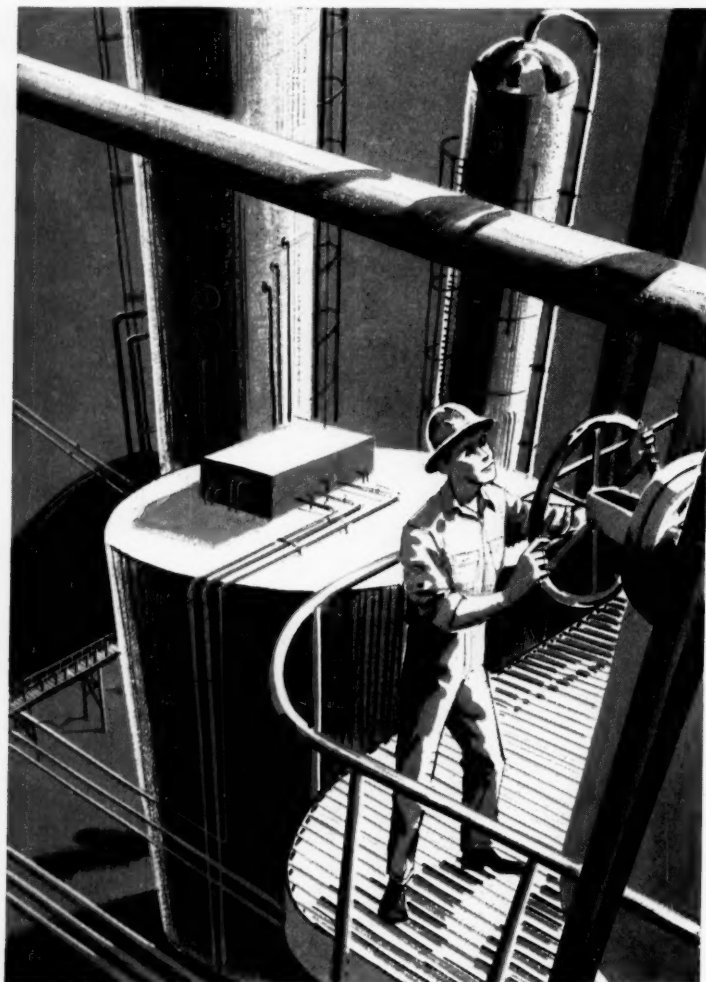
Zone _____

State _____

This Hot-Dip Aluminum-Coated Steel Provides Low-Cost Resistance to Atmospheric Corrosion

New steels are
born at
Armco

Armco ALUMINIZED STEEL Type 2 proves economical for weather shielding and insulation jacketing on reactors, drums, processing towers, boilers and piping.



Combining the surface characteristics of aluminum with the strength of steel, Armco ALUMINIZED STEEL Type 2 is proving especially useful wherever low cost protection against atmospheric corrosion is needed. Its durability has been proved in varied plant service and in 20-year exposure tests. These indicate that the hot-dip aluminum coating lasts at least three times as long as the zinc coating on unpainted commercial galvanized steel sheets.

Armco ALUMINIZED STEEL Type 2, on the basis of equal thickness, costs less per sq. ft. than aluminum. And because its greater strength usually permits the use of thinner gages, additional savings are possible.

Bonus advantages provided by this two-in-one metal are the increased safety that results from its high strength, its ability to reflect a high percentage of incident radiant heat, and its ability to resist damage by fire.

On the basis of its proved performance in industrial atmospheres, chemical plant and refinery engineers are specifying Armco ALUMINIZED STEEL Type 2 as a standard material for protective shielding and jacketing applications.

Try this unique aluminum-coated steel in your plant—see how its advantages can cut your maintenance problems. Write us for complete information on the properties and applications of ALUMINIZED STEEL Type 2. Armco Steel Corporation, 3369 Curtis Street, Middletown, Ohio.

ARMCO STEEL



Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation

NO MOVING PARTS

Designed to indicate media level changes through simple differential capacitance measurement, the new Robertshaw Level-Tel 154 contains no moving parts to clog, wear or jam.

SIMPLE TWO-STEP CALIBRATION

Only two quick, non-interacting adjustments are necessary to calibrate the new Level-Tel 154.

ANTI-FOULING PROBES

Self-cleaning Teflon probe assemblies remain free of deposit build-up, are unaffected by most cohesive substances.

Built to handle the Tough Jobs!

New Robertshaw CONTINUOUS LEVEL INDICATOR

REMOTE INSTALLATION

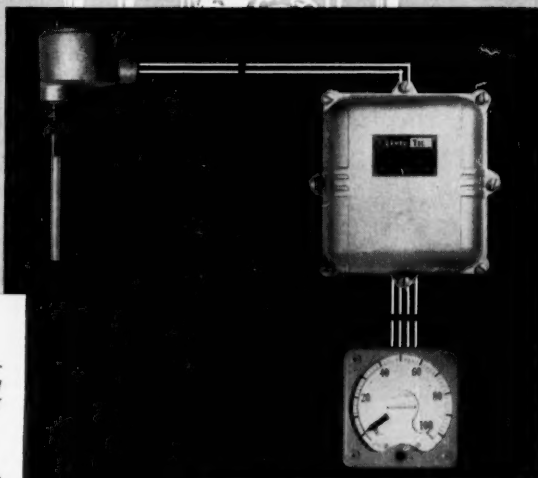
Over 200 ft. cable length permissible between probe and transmitting unit—virtually unlimited cable span between transmitter and indicator unit.

WIDE TEMPERATURE RANGE

Detector circuitry operable in temperature environments from -30°F to $+212^{\circ}\text{F}$. Teflon insulated probes from -325°F to $+350^{\circ}\text{F}$. Uninsulated probes up to 850°F .

The Level-Tel 154 is a precise, continuous reading level indicating system consisting of a probe detector, transmitter, and indicator. The probe conduit houses a miniaturized capacitance bridge circuit, energized by a regulated Hartley oscillator in the transmitter. In operation, the probe detects media level change as a change in capacitance, unbalancing the capacitance bridge. This out-of-balance condition is fed to the indicator via the transmitter as a DC signal proportional to the level change.

The new Level-Tel 154 is ruggedly designed for accurate operation. It may be used with nearly all liquids, slurries, powders and granular solids. Virtually insensitive to temperature and pressure extremes, the system functions reliably under difficult conditions, i.e., interface, mass measurement, corrosive materials, food processing, cryogenic liquids, combustible substances, and abrasives. It is available in either explosion proof or water tight housings. Let the modestly priced Level-Tel 154 start saving you money now! Write for Bulletin RF-5915 and the address of our nearest technical field representative.



HIGH ORDER LINEARITY

Unique detector circuitry permits system linearity consistent with demanding process control requirements.

BUILT-IN TEST CIRCUITRY

Functional system checkout and calibration are simply accomplished by depressing a test circuit button on the control panel indicator.

SIMPLE MAINTENANCE

Printed circuit wiring and plug-in provision for critical components assure minimum maintenance time.

SET POINT CONTROL

High and low level indicator set points adjustable at control panel.

ENGINEERS! Dynamic growth offers expanding opportunities to qualified EE's and ME's. Send resume to R. A. Sweeney.



AERONAUTICAL AND INSTRUMENT DIVISION

SANTA ANA FREEWAY
AT EUCLID AVENUE
ANAHEIM,
CALIFORNIA

**model H-25 PAYLOADER® "faster cycles
plus large load-carrying capacity"***



***Says Clyde T. Puryear, Plant Supt. of Hi-Acres, Inc., Fertilizer Division, Groveland, Florida, "the H-25 'PAYLOADER' is working out very satisfactory with faster cycles plus large load-carrying capacity. The power-shift transmission supplies accurate, smooth power to dig full bucket loads. It is well-balanced to handle the bucket load on fast delivery. There is no lost motion."**

Hi-Acres is a typical fertilizer mixing plant—typical in the large amount of bulk material handling that is needed and typical in that "PAYLOADER" tractor-shovels are "standard" for handling the bulk of such work.

The model H-25 unloads box cars, carries fertilizer ingredients from the various bins to the hopper of the bagging operation, does general clean-up and plant maintenance.

This "PAYLOADER" is the most concentrated package of tractor-shovel ever designed in its size range. Its combination of 2,500 lb. carry capacity, only 6 ft. turning radius, power-shift transmission, power-steering and power-transfer differential move big tonnages efficiently even in close quarters. For full H-25 data call your Hough Distributor or return the coupon.

THE FRANK G. HOUGH CO.
754 Sunnyside Ave., Libertyville, Ill.

Send full H-25 "PAYLOADER" data

Name _____

Title _____

Company _____

Street _____

City _____

State _____

12-A-1

HOUGH®



THE FRANK G. HOUGH CO.

LIBERTYVILLE, ILLINOIS

SUBSIDIARY — INTERNATIONAL HARVESTER COMPANY





Cleveland Speed Variators help maintain high quality of Philprene Polymers

At Phillips Chemical Company, Borger, Texas, engineers report "Degree of agitation is a most important variable in the coagulation of synthetic rubber latices."

Phillips Chemical uses 17 Cleveland Speed Variators in their Copolymer plant to provide the necessary process flexibility when changing from one type of their Philprene synthetic rubber to another.

These rugged Variators permit close control of coagulation tank agitation at the optimum level for each type of rubber produced, and help maintain the high quality of all their Philprene polymers.

Better check and see if Cleveland Speed Variators can't improve your operation. All the necessary information is contained in free Bulletin K-200. Write for your copy today.

The Cleveland Worm & Gear Company, Speed Variator Division,
3275 East 80th St., Cleveland 4, Ohio.

Sales representatives in all major industrial markets.
In Canada: Peacock Brothers Limited.

HOW IT WORKS

Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts. Relative speeds of the shafts are adjusted by changing the positioning of the axles on which the balls rotate (see cutaway view, right).



CLEVELAND



VARIATOR

FOR SEVERE CORROSIVE CONDITIONS

Specify ALUMINUM GATE VALVES

by Darling



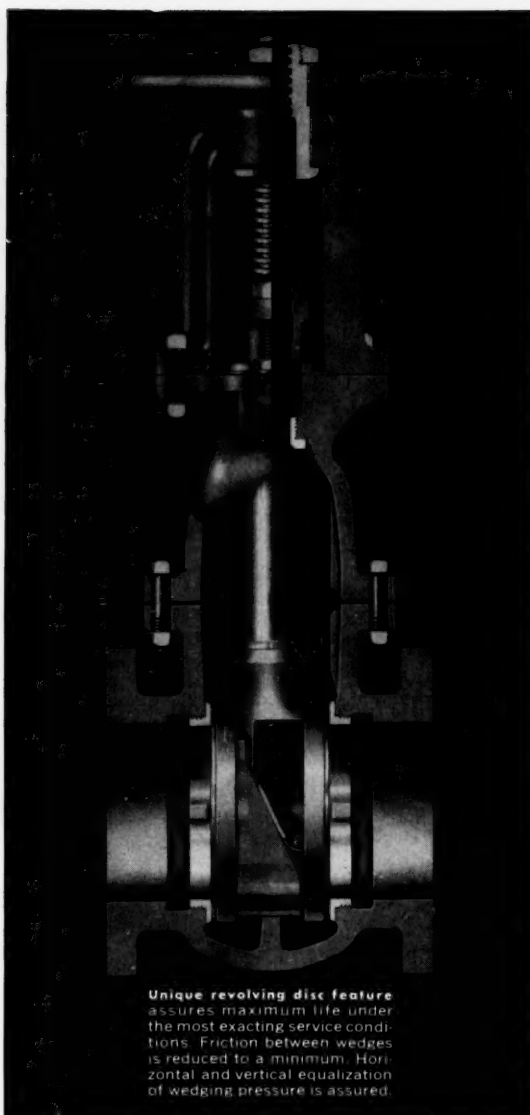
Handling corrosive chemicals such as hydrogen peroxide, ammonium nitrate, acetic acid, concentrated nitric acid? Darling Aluminum Gate Valves give you longer life, cut maintenance costs, under these and other severe service conditions. Here's why:

Darling metallurgical engineers have thoroughly tested and standardized on the most highly corrosion-resistant aluminum alloys in use today.

Accurate casting control and precision assembly reduces friction and wear, provides maximum ease of operation.

Darling Double Disc Parallel Seat principle assures freedom from leakage, trouble and downtime.

Darling aluminum alloy valves are available in sizes from 1/2" through 24". Write us about your requirements and service conditions.

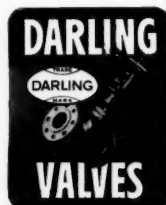


Unique revolving disc feature assures maximum life under the most exacting service conditions. Friction between wedges is reduced to a minimum. Horizontal and vertical equalization of wedging pressure is assured.

DARLING VALVE & MANUFACTURING CO.

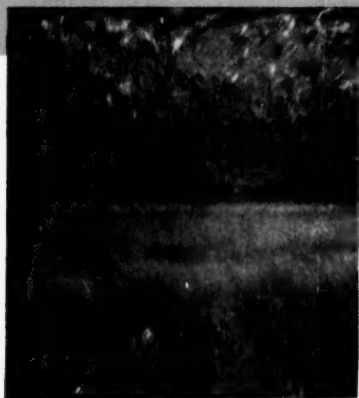
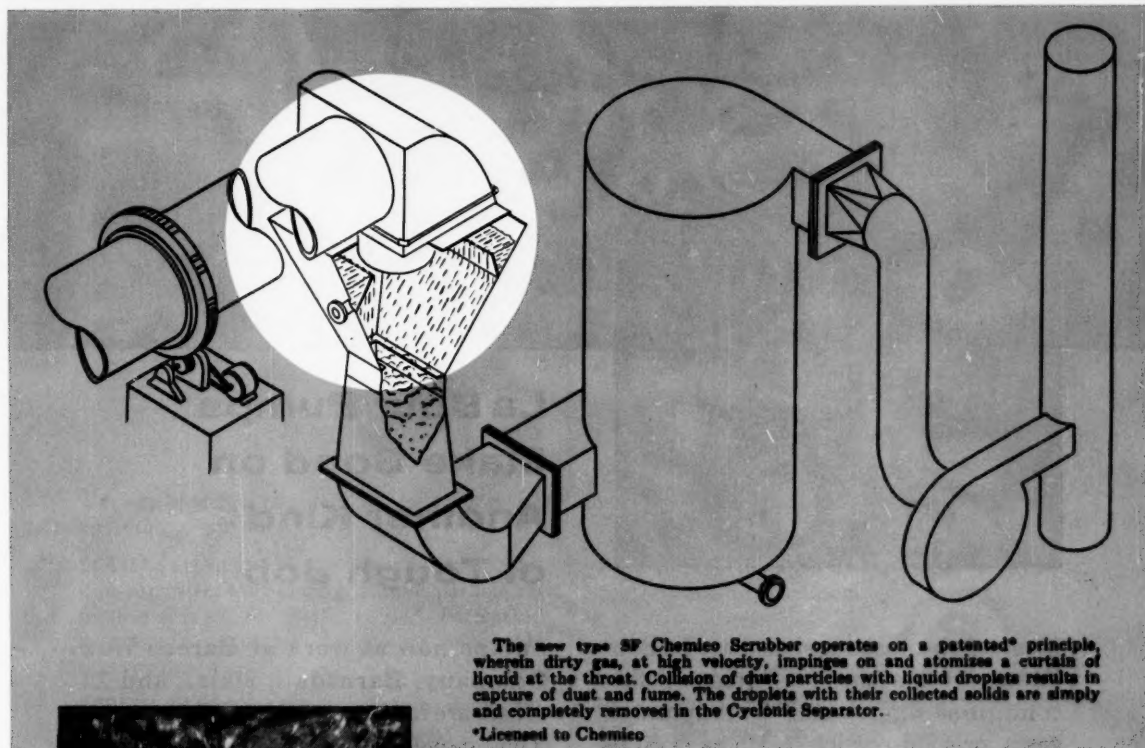
Williamsport 3, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.



CHEMICO VENTURI SCRUBS LIME KILN GASES WITH SLURRY CONTAINING 45% SOLIDS!

99% Scrubbing efficiency! Maintenance-free operation!



Actual photograph of throat action

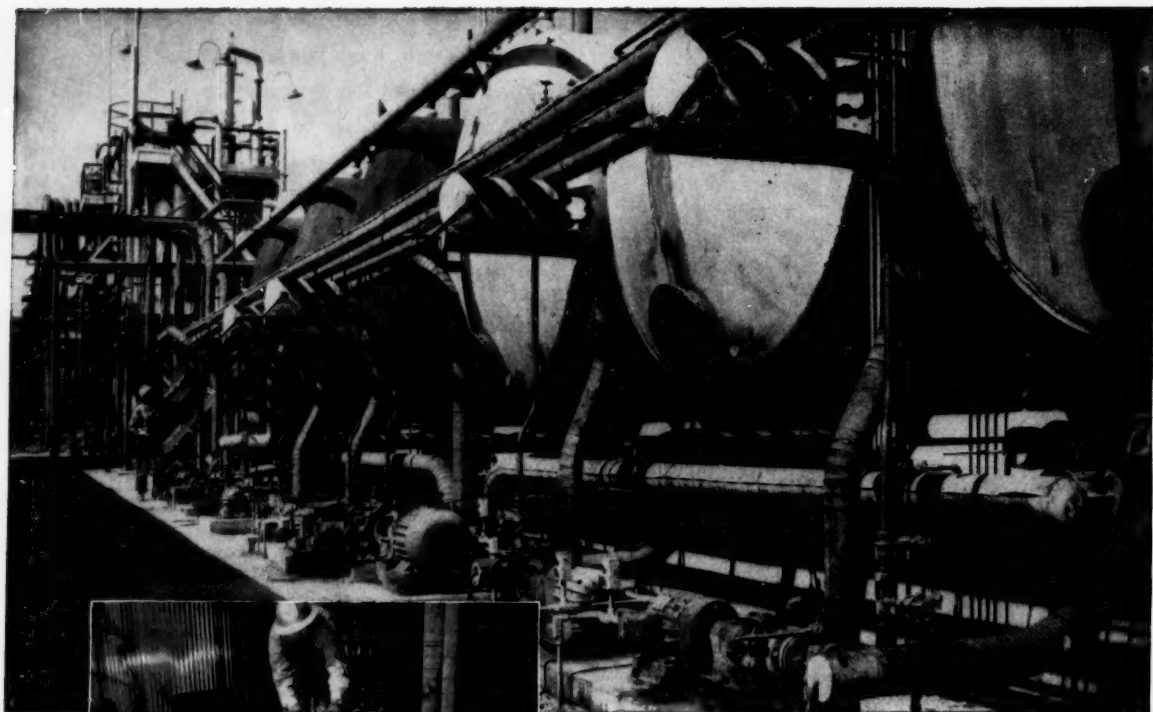
The new type SF CHEMICO Venturi Scrubber is handling 40,000 cfm of hot gases from a 8½' x 250' rotary kiln at the Hudson Pulp & Paper Corporation and achieving over 99% removal of lime! This new type SF unit was developed to facilitate handling of scrubbing liquids containing large lumps, heavy solid concentrations or solutions likely to scale heavily, and utilizes large open weir troughs to distribute the liquid. It has no small passages subject to plugging by either gas or liquid.

Proof of the effectiveness of this new design is the fact that, despite the use of a recycled slurry containing over 45% solids and many large lumps, the Hudson operators report that no maintenance difficulties have been experienced and that the unit is virtually "trouble-free."

The Chemico type SF Venturi Scrubbers are low cost, compact and readily installed in your plant. Your inquiry will receive prompt attention from Chemico's Scrubber Department.



CHEMICAL CONSTRUCTION CORPORATION
525 West 43rd Street, New York 36, New York LOngacre 4-9400



La Bour Pumps Make Good on Another Kind of Tough Job

Most of the tasks assigned to LaBour Pumps involve corrosive liquids, suction conditions aggravated by vapors or gases, or solid particles such as crystals or dirt. Sometimes all three appear in one application. But here's a job with none of these problems, yet it took the unique design and capabilities of LaBour to provide a satisfactory solution.

There are 32 La Bour Type DZT

pumps now at work at Bareco Wax Company, Barnsdall, Okla., and 12 others are in process of installation there. They move wax, at temperatures above 200° F., through all stages of manufacture. Pumps and lines are steam-jacketed throughout.

Whatever your problem in handling process liquids, corrosive or otherwise, it will pay you to get in touch with La Bour.

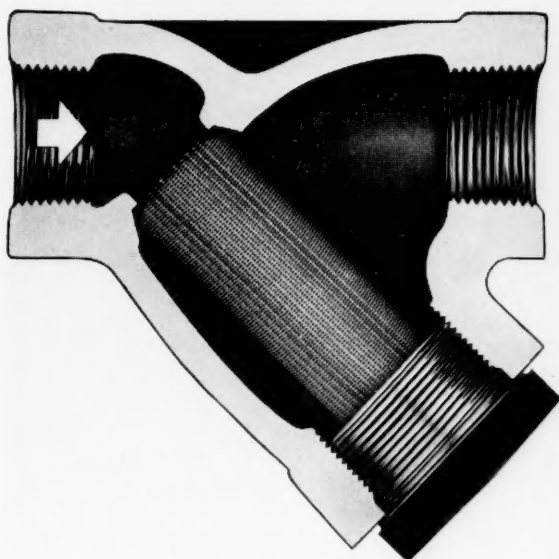
ORIGINAL MANUFACTURERS OF THE SELF PRIMING CENTRIFUGAL PUMP

LABOUR

THE LABOUR COMPANY, INC. • ELKHART, INDIANA, U. S. A.



FROM MONEL SCREEN TO PARKERIZED BODY THEY'RE YARWAY QUALITY



Yarway pipe line strainers are *built for service*—combine more outstanding quality features than any other strainer.

SCREENS are of fine Monel woven wire—sturdy, non-corrosive, long-lasting. Round particle retention size range: .008" to .011". Perforated screens also available. All screens removable and replaceable.

SCREEN CAPS have straight threads, machined faces, spark-plug-type gaskets. Screen comes out with screen cap for easy cleaning. Cap screws back tight without excessive force.

TAPERED SEAT in body, plus straight thread on cap, insure proper alignment, tight fit when screen is replaced after cleaning.

PARKERIZED BODY FINISH, *inside and out*, protects against corrosion.

BODIES on standard strainers are cast iron or steel, screwed, socket-weld or flanged connections. Bronze, stainless steel and aluminum bodies also available.

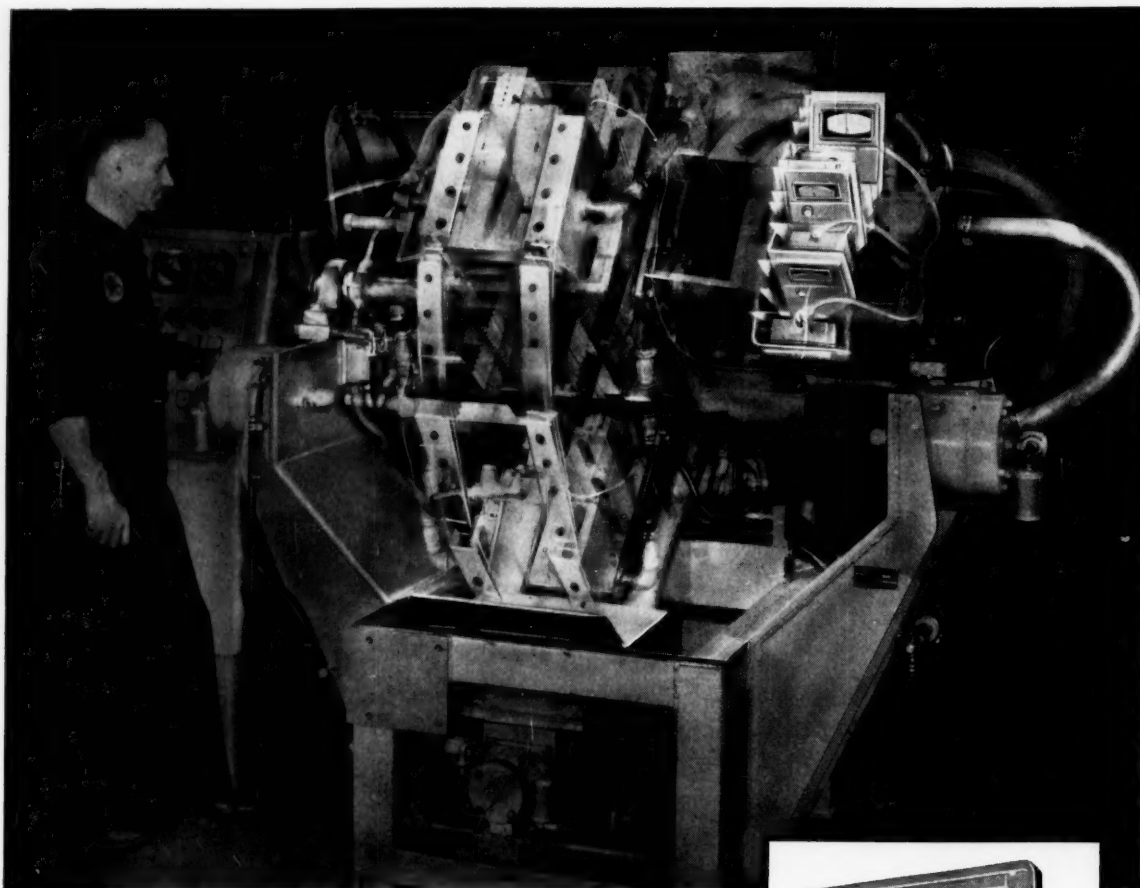
SIZES and PRESSURES—Screwed, 1/4" to 3"; pressures to 600 psi. Socket-weld, 1/4" to 3", pressures 600 and 1500 psi. Flanged, 1/2" to 5", pressures to 600 psi.

For long life, for effective service, you can't buy a better strainer—and Yarways are cheaper in the long run.

Yarway strainers are stocked and sold by the same 270 Industrial Distributors who sell Yarway Impulse Steam Traps; one near you. Write for Bulletin S-205.

YARNALL-WARING COMPANY, 100 Mermaid Ave., Philadelphia 18, Pa.

YARWAY FINE SCREEN STRAINERS



A Partlow Model MFS indicating controller is shown in action in this "multiple exposure" shot of a Holo-Core Automatic Molding Machine manufactured by Spo, Inc., Cleveland, Ohio.

The Temperature Control Built to **SHRUG OFF SHOCK** *2438 Times a Day*

Every working day, the Partlow Temperature Control in this photo takes between 2400 and 2500 solid "roundhouse punches" from the shell-molding machine to which it is attached.

But despite jarring shock and vibration, and a constant barrage of foundry dust, the Partlow goes right on delivering precision control—without letup or breakdown.

Actually, only a control as simple and rock-solid as the Partlow could withstand this kind of punishment! Because only the Partlow contains no hairsprings, or delicate gadgets.

All Partlow thermal elements of the same range are interchangeable *on the job*, too. There's no time lost waiting for your control to

come back from the factory. And you get this extra margin of dependability *without loss of accuracy*. Partlow controls are precise to within 1% of scale in any one of 10 ranges from -30° to 1100° F.

If you use or manufacture equipment within this temperature range, there's a Partlow to fit your application exactly . . . and save you money, too. Available in Pneumatic, Electric or Self-Contained Gas types, in recording, indicating or non-indicating models! To field test any Partlow control . . . or to obtain full details write, The Partlow Corporation, New Hartford, N. Y. Dept. E-129.

Export: Ad. Auriema, Inc., 85 Broad St., New York 4, N. Y.



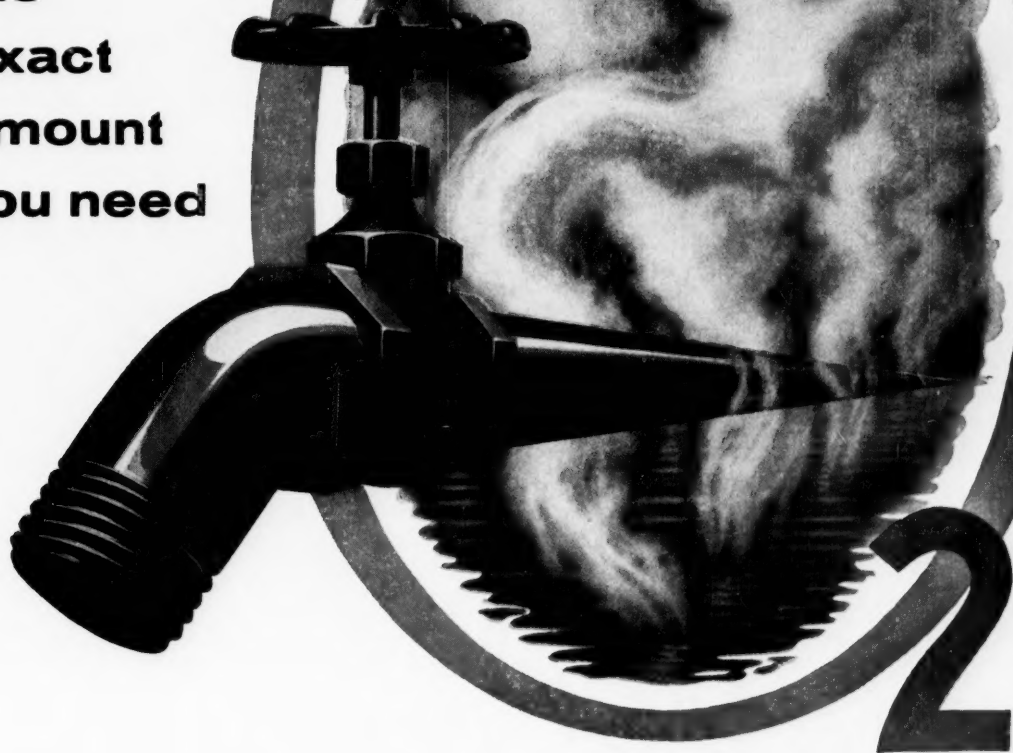
A complete absence of gadgets and superfluous parts, as seen in this open view of the new MFS indicating control, explains the Partlow's unique ability to function accurately even under the most severe operating conditions.

You can pay more but you can't buy better than

PARTLOW
TEMPERATURE CONTROLS

OXYGEN

the
exact
amount
you need



You get it instantly—from LINDE

You have no worries whatever about an ample, dependable supply of oxygen for your process when you buy oxygen from LINDE. Full responsibility for production, transportation, and storage at your plant is assumed by LINDE.

Tonnage oxygen. Large amounts of liquid or gaseous oxygen can be supplied from a full-scale oxygen production unit—built and maintained by LINDE—directly to your plant. You pay only for the oxygen you use, at a price guaranteed by LINDE, with no capital investment on your part.

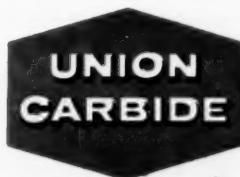
For varying needs. A DRIOX oxygen storage unit provides a continuous flow of liquid oxygen, or converts it automatically to gas. Constant pressure is maintained, even while the unit is being replenished. Or you can get LINDE oxygen in a single flask, a cylinder, or banks of cylinders.

The terms "Linde," "Driox," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

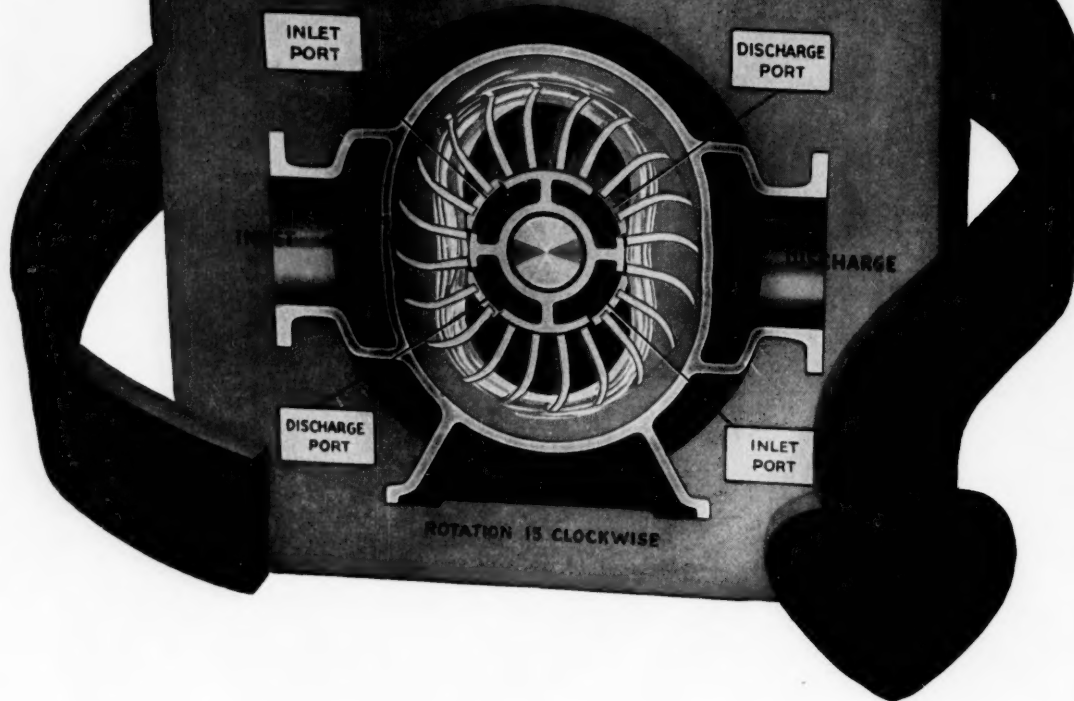
Take advantage of LINDE's 50 years of development and service in the industrial gas field! Write, phone, or wire Dept. CE-123, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. In Canada: Linde Company, Division of Union Carbide Canada Limited.

When you need Oxygen—call LINDE!

Linde
TRADE-MARK



**Nash Instrument Air Compressors
deliver only clean air, free from
oil or dust, and without filters**



Here is Why!

You can dispense with oil filters and dust filters when you install [®]Nash[®] Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

[®]Nash[®] Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.

No dust filters.

No internal lubrication to contaminate air handled.

No internal wearing parts.

No valves, pistons, or vanes.

Non-pulsating pressure.

Original performance constant over a long pump life.

Low maintenance cost.

NASH ENGINEERING COMPANY
395 WILSON, SO. NORWALK, CONN.



Here, boiling nitric acid is used to evaluate the corrosion resistance of Jessop stainless steel plate.

"How Jessop Tests Stainless Steel in Boiling Nitric Acid"

L. W. Cooper, Chief Metallurgist

"From experience, our customers know this is a fact: Specify Jessop for specialty steels . . . and then relax! Of the many reasons *why* this is true, here's one . . .

"In evaluating corrosion resistance, one of the procedures we use is the ASTM boiling nitric acid test. Standard and simple? Yes. But expert *evaluation* is of great importance to the

customer. That's why, at Jessop, a top metallurgist closely supervises each of the five 48-hour test periods.

"Overly cautious? Because we're overly cautious in every phase of steel production and quality control, Jessop has earned the reputation for producing specialty steels tailor-made to the most exacting specs—Specify Jessop . . . and then relax!"



Checking the grain size of tool steel, this Jessop metallurgist uses a microscope with a camera attachment.

VMA 6787

Green River Steel Corporation
Jessop Steel of Canada, Ltd.

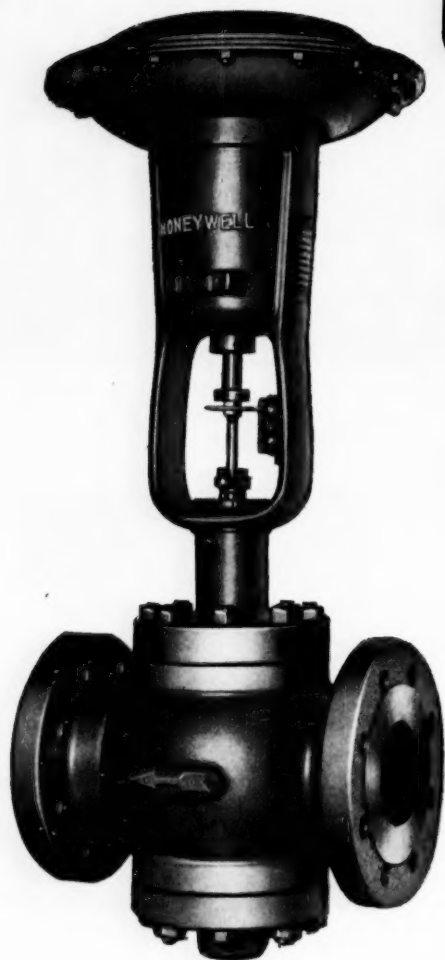
Jessop Steel International Corporation
Steel Warehousing Corporation, Chicago

JESSOP
STEEL COMPANY
Washington, Pennsylvania

Stainless, alloy, tool, cast-to-shape, clad, and forging steels, ground flat stock and other specialty steels

is your

PROCESS FLOW CORROSIVE?



**Honeywell control valves are available
in a wide range of materials**



Whether you're talking about corrosive or non-corrosive fluids, there's a Honeywell automatic control valve for your particular process flow. It is available in any castable body material and trim material such as . . . stainless steels, Hastelloy, Monel and Durimet

20. This variety of materials permits economical construction to fit your corrosive process flow application.

For corrosive or non-corrosive flows . . . or other process flow conditions . . . Honeywell valves are available in a wide range of types and sizes. When you need control valves . . . contact your local Honeywell field engineer. Write for new Catalog C800-1.

MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.

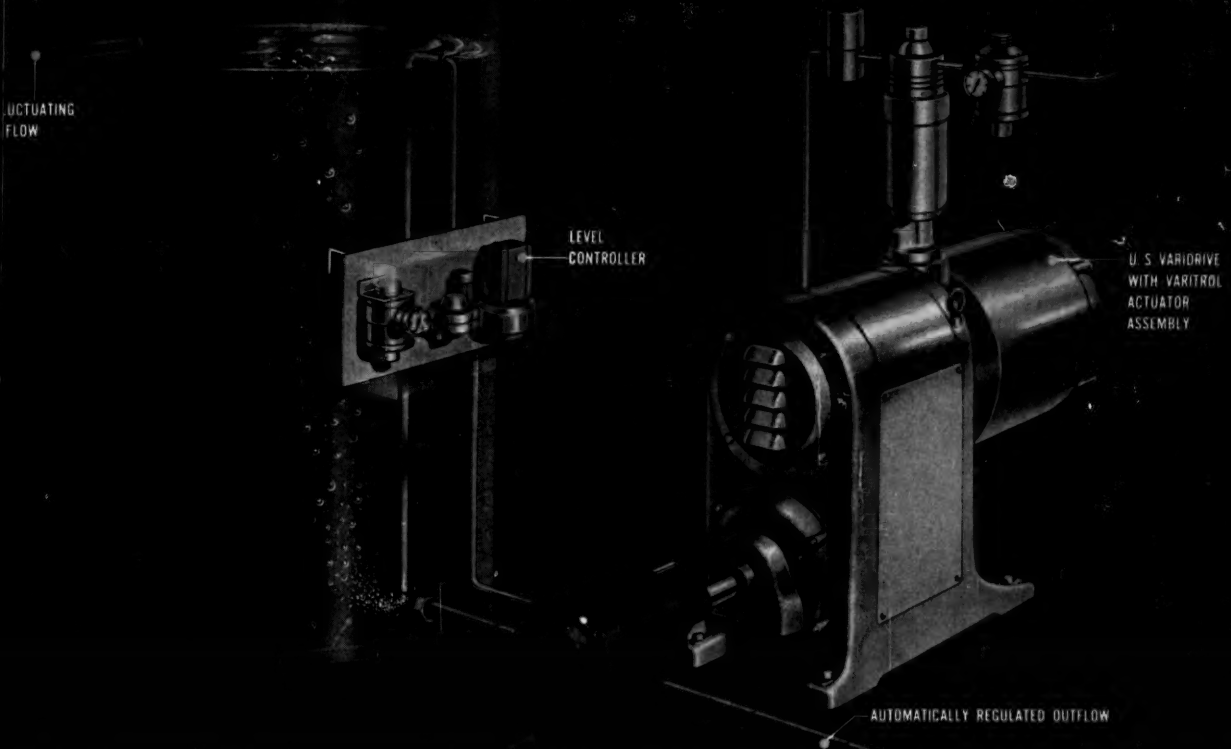
Honeywell



First in Control

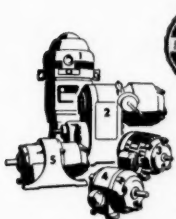
liquid level automatically controlled

...WITHOUT ELECTRONICS!



using adjustable speed **U.S. Varidrive** *with* **VARITROL** *automatic speed control*

This U.S. Liquid Level Control System adjusts pump motor speed to maintain constant level in open tanks such as those used in food, petroleum, sewage or chemical processing industries. Pumping is continuous. Level can be held as close as $\frac{1}{4}$ " when necessary. No electronic circuitry, no special technicians required to maintain and operate equipment. Many other U.S. controlled speed systems with U.S. Varidrives regulated by Varitrol are available for production involving gases, liquids or solids. Write for brochures.



U.S. ELECTRICAL MOTORS INC.

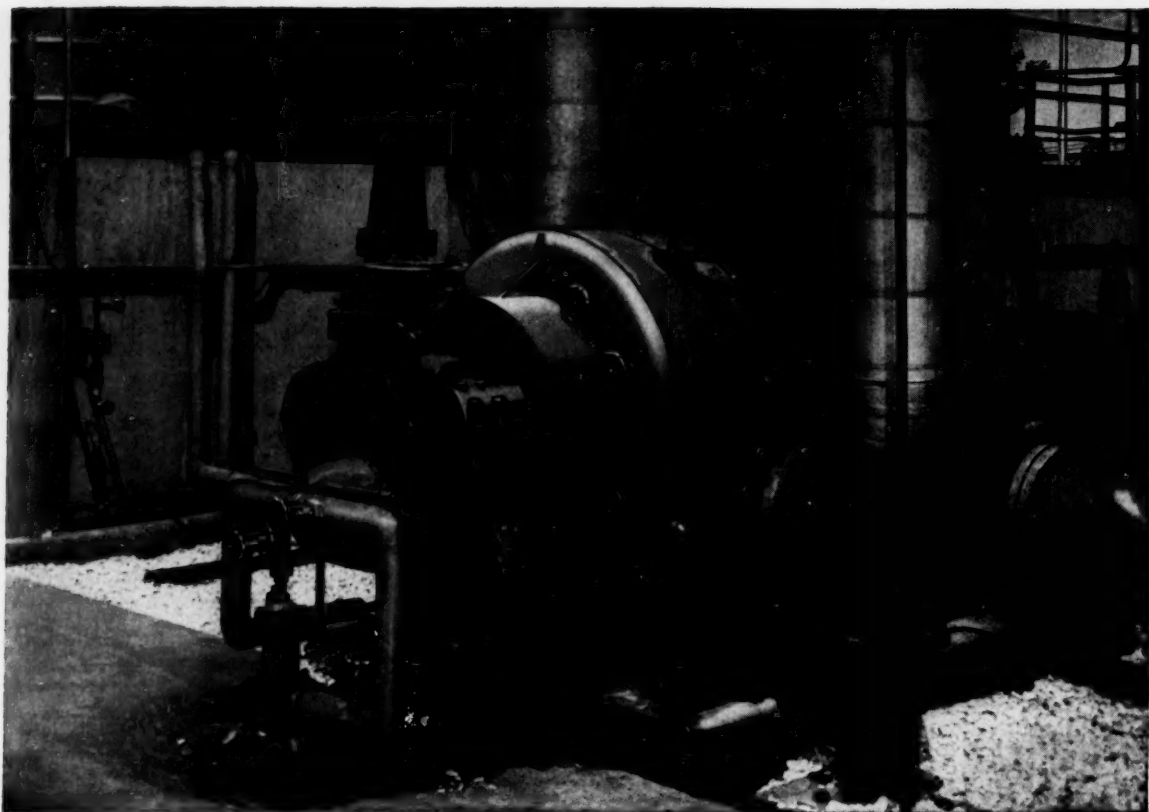
P. O. BOX 2058
LOS ANGELES 54, CALIFORNIA
OR MILFORD, CONNECTICUT

U.S. MAJOR MOTOR LINES INCLUDE:

1. Vertical Solid & Holloshaft, 2. Varidrive, 3. Totally-Enclosed,
4. Unclosed, 5. Syncrogeared. Also, many other special motors.

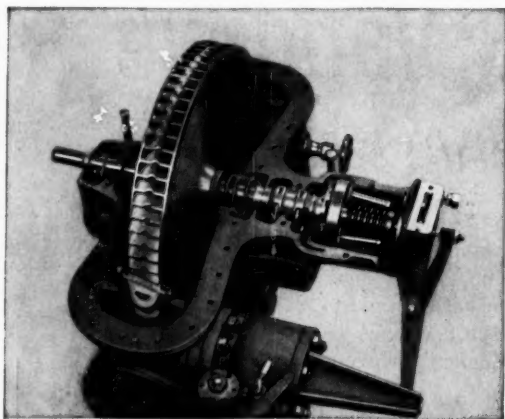


FREE ILLUSTRATED BROCHURES... send for *Controlled Speed Systems Bulletin F-1952; Varitrol Bulletin, F-1882; Varidrive Bulletin, F-1797.*



TERRY SOLID-WHEEL TURBINES

used exclusively at Baton Rouge plant of W.R. Grace & Co.



The upper photograph shows one of the 17 Terry turbines installed at the Baton Rouge, La., GREX high-density polyethylene plant of W. R. Grace & Co. Above, a typical Terry solid-wheel turbine with cover removed to show the wheel construction.

In purchasing equipment for their new 50,000,000-pound high-density polyethylene plant, W. R. Grace & Co. standardized, wherever possible, on a single source of supply for each type of equipment used. Consistent with this policy, Terry steam turbines were used exclusively throughout the utility and process sections of the plant.

A total of 17 turbines were placed in service for driving pumps and fans. These are all of the solid-wheel type, ranging in capacity from 50 to 240 HP.

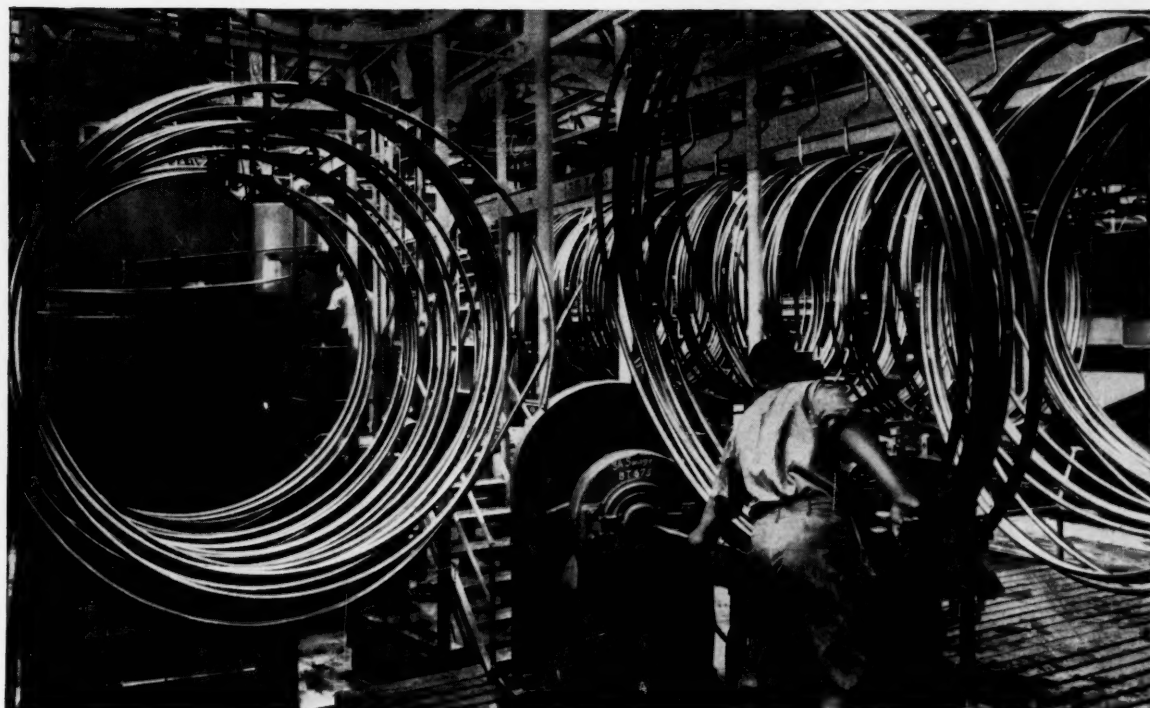
Terry solid-wheel turbines are known for their long life and sure dependability under the most-trying operating conditions. They feature a single-piece wheel which is virtually indestructible.

Send for details of these trouble-free turbines. Ask for a copy of bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1214



things you should know about

WOLVERINE TUBE

You know what they say—about change being the father of progress.

Well, that's the way it is at Wolverine Tube and we'd like to tell you about some of the new things going on at Wolverine.

For example, Wolverine recently completed a multi-million dollar modernization program at its Detroit, Michigan plant. New machinery and new tube-making techniques have made this plant one of the most modern in North America. Wolverine also operates large, modern plants in Decatur, Alabama and London, Canada.

There are new things afoot metalwise at Wolverine, too. In addition to copper and aluminum, Wolverine Tube now works in such metals as Columbium, Molybdenum, Tantalum, Titanium, Vanadium and Zirconium, etc. It's the result of an extensive research program started many years ago, and it gives Wolverine customers a big edge when they require an experienced tubing and fabrication source for these "metals of tomorrow."

Also, to insure top-flight sales service, Wolverine has expanded its nation-wide sales staff to include a number of highly trained Technical Sales Representatives. These men are specialists in all phases of tubing selection and application, particularly in the field of heat transfer. Their services are available at all times . . . you have only to ask.

So . . . if your company is looking for the finest of tubing and the finest of service, you'll find both at Wolverine Tube where improvement is a continuing program.

CALUMET & HECLA, INC.
CALUMET DIVISION
URANIUM DIVISION
GOODMAN LUMBER DIVISION
WOLVERINE TUBE DIVISION

In Canada:

CALUMET & HECLA OF CANADA LIMITED
WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO. LTD.
UNIFIN TUBE DIVISION



WOLVERINE TUBE

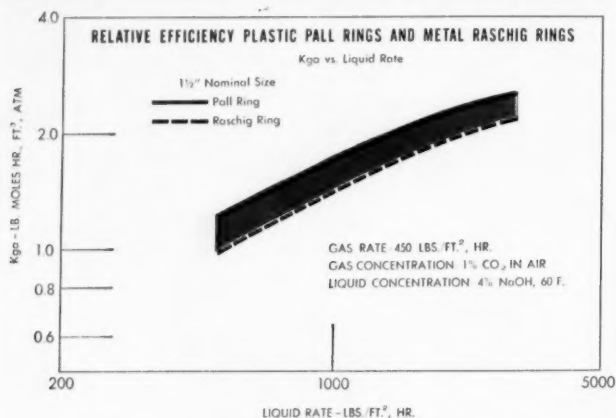
DIVISION OF
CALUMET & HECLA, INC.

17232 Southfield Road
Allen Park, Michigan

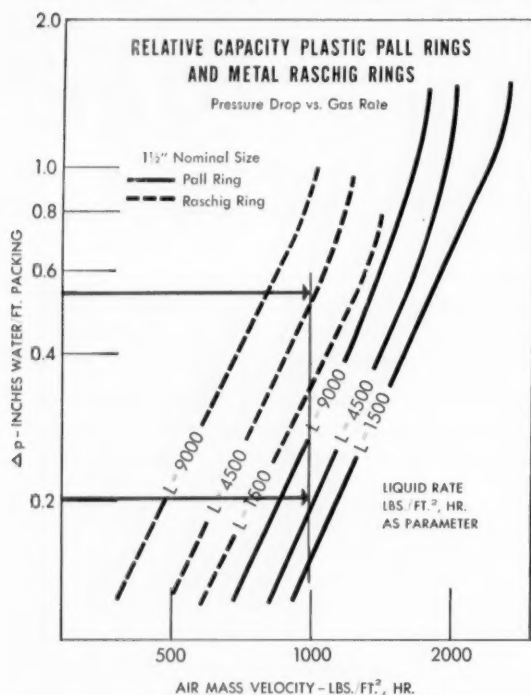
Manufacturers of Quality Controlled Tubing and Extruded Aluminum Shapes

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES

NOW PALL RINGS in PLASTIC



Kga data, obtained in one of our 30" experimental towers, reflects the much greater efficiency of plastic Pall Rings.



Pressure drop data likewise reflects the high capacity of plastic Pall Rings. For example, pressure drop through metal Raschig Rings at a gas rate of 1000 lbs./ft.², hr., and a liquid rate of 4500 lbs./ft.², hr., is almost three times greater than through plastic Pall Rings.



The remarkably efficient Pall Ring, first introduced on the American market in 1957, in metal, is now available in polypropylene and high density polyethylene;* in four sizes: 5/8", 1", 1½" and 2".

Pall Rings in plastic offer the same striking advantages of low pressure drop and high capacity at less than one-fourth the weight. (For example, 1½" Pall Rings in carbon steel weigh approximately 23½ lbs. per cu. ft. In plastic, only 4¼ lbs.)

Take a look at the graphs showing comparative efficiency data and capacity data for metal Raschig Rings and plastic Pall Rings . . . data prepared from test runs in one of our 30" diameter experimental towers. The differences stem entirely from the characteristics of the two rings. In the Pall Ring the inner projections of the wall become active working surfaces as opposed to the relatively "dead" inner wall of the Raschig Ring.

The conclusions are inevitable: tower volume can be substantially reduced by using Pall Rings (either metal or plastic) in place of Raschig Rings.

*On special order, Plastic Pall Rings can also be supplied in PVC and polystyrene.



U. S. STONEWARE
AKRON 9, OHIO

NEW YORK • CHICAGO • HOUSTON • LOS ANGELES

DEVELOPMENTS ...

DECEMBER 14, 1959

Chementator

T. PETER FORBATH

Ashland Oil, co-developer with UOP of Hydeal (Chementator, Oct. 19, p. 98), will be first to commercialize the hydrodealkylation process. Company plans a plant at Buffalo, N. Y., to make either 12 million gal./yr. benzene or 50 million gal./yr. naphthalene, or combination of both.

Russians are reported to have a 20-30,000-ton/yr. polyisoprene plant on stream.

Quebec South Shore Steel is going ahead with plans for a Udy-process steel plant (Chementator, Oct. 19, p. 95). Construction will start next spring on a \$22-million, 150,000-ton/yr. facility near Montreal, to be completed in 1961.

Allied Chemical reportedly will build a 56,000-ton/yr. ammonium sulfate plant at El Segundo, Calif. It's expected on stream by late '60, will free Allied of outside suppliers on West Coast.

Trend to "baby" maleic plants?

Utah Resin Co.'s new maleic-fumaric plant in Salt Lake City (*Chementator*, Oct. 19, p. 98) is raising more than a few anxious eyebrows. Puzzler: Can a small company like URC build a small plant (2.4 million lb./yr. compared with the 20-million-lb./yr. plants usually built) and make money?

URC's answer: Yes, if you build plant for around \$60,000 as it did instead of for around \$1 million as at least one engineering firm with solid experience in the maleic-fumaric business estimated it should cost. In way of explaining this striking savings in investment cost, company president Robert Koch—who designed URC's unit—points out that an inexpensive instrumentation and heat removal system was developed for the plant. Too, he notes, labor costs are low in Utah, furthermore URC charged itself less for engineering than would have an outside engineering company.

Should URC's view prove out, it could change the whole maleic marketing picture, say industry observers. If a maleic consumer can economically build a small plant for itself, there no longer may be a need for big outside suppliers of the material, they speculate.

NH₃ regenerates water-treating resin

Use of ammonia, rather than caustic soda, for regenerating water-demineralizer anion resin beds may be the solution to mounting rinse requirements that traditionally plague these units as they age.

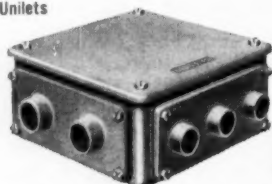
Cochrane Corp. (Philadelphia) recently converted a 1,800-gpm. process-water-treatment unit at Mobil Oil's Paulsboro, N. J., refinery from caustic to ammonia regeneration, reports that rinse time on the demineralizer has been sliced in half as a result. Moreover, the switch in regenerants cut regenerant cost by 16% and salvaged some 70% of the rinse water previously wasted. In terms of hard cash, these figures mean savings of about



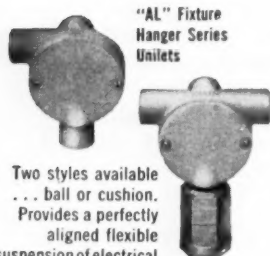
"V-51" Vapor-Tight Lighting Fixture Unilets

Vapor-tight lighting fixture series for use with rigid conduit. Known for its patented unit construction. Reflector and guard can be put on and taken off quickly...without tools! Designed for easy installation plus simple maintenance.

"RS" Series Malleable Unilets



A universal junction Unilet box permitting flexibility of hub arrangements for easy adaptation in the field. Water-tight!



"AL" Fixture Hanger Series Unilets

Two styles available...ball or cushion. Provides a perfectly aligned flexible suspension of electrical fixtures and allows a swivel to 20° in any direction.

"FS" and "FD" Series Unilets



Weather-proof housings for junctions, receptacles and switches...for use outdoors or in. One, two, three and four-gang styles.



"AE" Plug and Receptacle Series Unilets

"AE" Series 30, 60, and 100 ampere plugs and receptacles come equipped with solderless connectors and replaceable interiors. Choice of lift cover, or threaded cap types.

APPLETON®

One of the most complete selections in the industry!

Yes, APPLETON can supply you...with a wide variety of Unilets for receptacles, switches, plain junctions, pilot lights, fixture hangers, etc. Ample wiring room. Assorted hub arrangements. *You name it, we've got it...* for indoors or out.

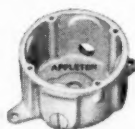
And every APPLETON product is made to the rigid quality standards pioneered by APPLETON engineers. They are easy to wire, are blemish free, have clean, chamfered threads conforming to N.P.T. requirements assuring a tight joint and positive ground. Next time you buy, specify APPLETON!

Form 35 Series Unilets



Threaded and no-threaded malleable iron series...taper threads...covers held by screws — will not vibrate loose...high quality finish...full line.

"JB" Series Vapor-Tight Unilets



With or without mounting lugs. 4 tapped holes and 2 close-up plugs or blank body without close-up plugs. ½", ¾" and 1" sizes for use as "E", "C", "T", or "X" bodies.

Sold Through Franchised Distributors Only

APPLETON ELECTRIC COMPANY

1701 Wellington Avenue

Chicago 13, Illinois



Also Manufacturers of:



Explosion-Proof Lighting Fixtures



"Eagle Claw" Outlet Boxes



"ST" Series Connectors



Reelites

\$6,100/yr. for Mobil, a company spokesman declares.

Mobil's water treatment unit includes six 9-ft.-dia. by 20-ft.-high anion columns loaded with 2,040 cu. ft. of polystyrene-polyamine weakly basic anion resin. It treats river water of 50-100 ppm. sulfate-plus-chloride content. When installed in 1954, the demineralizer was regenerated with NaOH, required rinse time of just 170 min. and wasted only 35,000 gal. of rinse water. But by the time the resin bed was five years old, these figures had risen to 388 min. and 116,500 gal., and promised to keep right on climbing with ageing.

In switching to ammonia, Mobil succeeded in knocking rinse time down to 169 min. and waste water to 31,500 gal.

GE's diamond-making process unveiled

Freed of a government secrecy order, General Electric last month unveiled its process for making synthetic diamonds. But almost before the ink on its process description could dry, GE discovered it wasn't the only firm that knew how to produce the man-made brilliants that are rapidly capturing the industrial diamond market.

DeBeers Consolidated Mines (Johannesburg, South Africa), which through various affiliates controls virtually all of the world's natural diamond sales, has applied for patents on a diamond-making process of its own, is now considering entering commercial production. And the Dutch firm of diamond cutters, Asscher's of Amsterdam, reports doing the same. Though DeBeers hasn't disclosed details of its process, Asscher's says its route is based on a system of "guided explosive charges" that provide the high temperatures and pressures needed in diamond making.

GE uses a molten metal catalyst (e.g., chromium, platinum, nickel, cobalt, iron, tantalum or manganese) that, as a thin film between carbon and growing diamond crystal, reduces pressures and temperatures required. Reports GE, without the catalyst, diamond-making would require 3 million psi. and over 7,000 F.—a combination impossible to sustain with presently available equipment. But with the catalyst, diamonds can be grown at 800,000-1.8 million psi. and 2,200-4,400 F.

Pressure cell producing these conditions consists of conical, cemented-carbide pistons that push into each end of a doughnut-shaped cemented-carbide chamber. Several stressed

binding rings support the chamber and pistons.

Carbon and catalyst are fixed in the cell by an aluminum silicate holder that transmits the pressure of the converging pistons. Temperatures needed are attained by passing electrical current through the carbon.

Dialdehyde starch goes commercial

Efforts to transform dialdehyde starch from a promising but expensive chemical into a competitively priced, commercially available product have succeeded (*Chementator*, May 18, p. 70).

- Miles Chemical swings on stream this month a 250,000-lb./yr. plant at Zeeland, Mich., already is working on plans to double capacity and visualizes "millions of pounds per year" output in the not-too-distant future.

- Newark College of Engineering (Newark, N. J.) has completed scaling up U.S. Dept. of Agriculture's 100-lb./week dialdehyde starch facility, is now shipping a 400-lb./day unit to USDA's Northern Regional Research Lab in Peoria, Ill.

- Abbott Laboratories is in the final stages of construction of a commercial dialdehyde starch plant at N. Chicago, Ill. And Warner-Lambert (Morris Plains, N. J.) has started a market study of the material with a view towards getting into dialdehyde starch production.

Technical root out of which this activity blossoms is USDA's process for continuously regenerating and reusing small amounts of the high-priced (\$25/lb.) periodic acid that oxidizes corn starch to dialdehyde starch. It cuts price of dialdehyde starch from \$30/lb. to 30-50¢/lb.

Newark College's facility, similar in most respects to the other commercial installations, centers on a polyvinyl chloride electrolytic cell wherein periodic acid is regenerated from the iodic acid made in starch oxidation. It consists of 16 anolyte chambers with 8 lead-oxide-coated lead anodes and 9 catholyte chambers with 9 perforated iron cathodes. Each chamber measures 3 ft. by 3 ft. by 2 in., is separated from adjoining ones by Pfaudler-Permutit Type 3171 cation exchange membranes. Catholyte is 5% NaOH, anolyte 90-95% iodic acid from which the periodic acid is generated.

Cell operates at 2,000 amp., 4-5 v., 20-amp./sq. ft. current density, 90% current

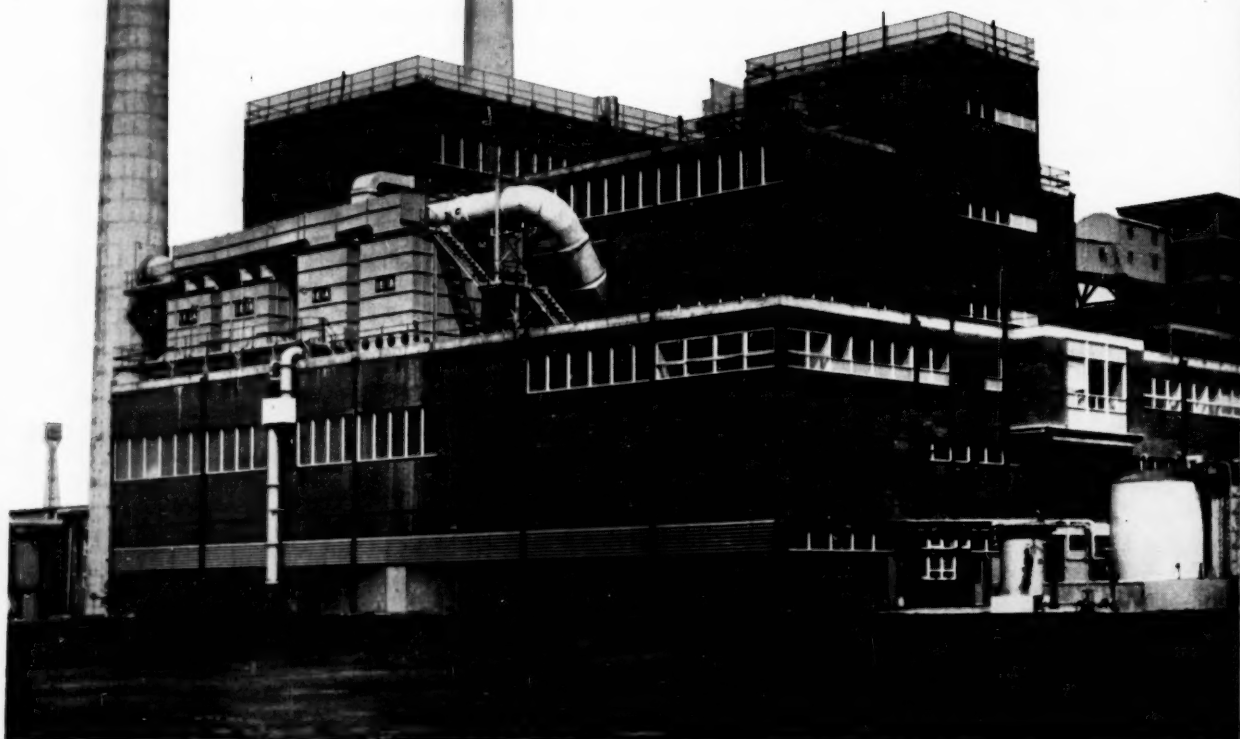
(Continued on page 74)

Designed by DORR-OLIVER for

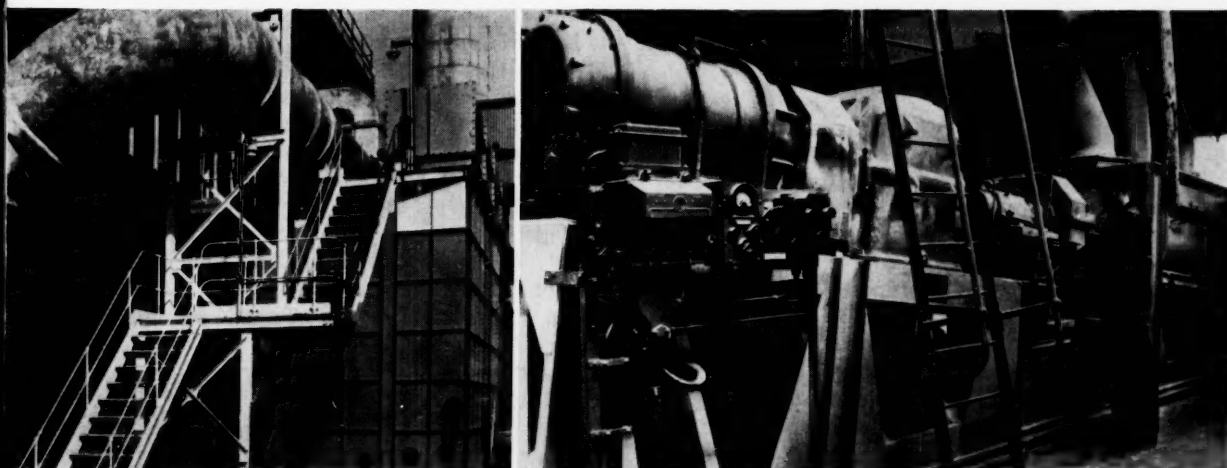


CONTROL ROOM permits centralized push-button operation. Flowsheet diagram includes running lights to indicate stages in processing.

LARGEST C.C.F. GRANULATION



Imperial Chemical Industries Limited



DOYLE SCRUBBERS are used for dust and NH_3 recovery and for cooling and condensation to minimize visible stack effluent.

DORRCO BLUNGER (2 installed) mixes fertilizer chemicals and starts granulation process, which is completed in large rotary dryers. Photo shows drive and feed end.

(Concentrated Complete Fertilizer) PLANT in the British Commonwealth

The more than 40-year-old experience of the Dorr-Oliver organization in designing or equipping nearly 50 fertilizer projects in 17 countries has been utilized in another spectacular development—the largest C.C.F. granulation plant in the British Commonwealth and one of the largest in the world.

The plant is the latest addition to the immense 1100-acre chemical complex operated by Imperial Chemical Industries Limited at Billingham, England. Sulphate of ammonia, monoammonium phosphate and muriate of potash are combined by the Dorrco Granular Fertilizer Process to form a concentrated complete 12-12-18 fertilizer. The two processing units comprising the plant produce a total of 1100 tons per day. Thanks to advanced design and extensive use of instrumentation, high productivity is achieved with a relatively small

labor force for operation and maintenance.

Examples of recently completed projects, in addition to the Billingham installation, include plants for The American Cyanamid Company at Brewster, Florida; Scottish Agricultural Industries Ltd., Leith, Scotland; W. R. Grace Co., Davison Chemical Division, Bartow, Florida, and The Olin-Mathieson Company at Pasadena, Texas. If you are interested in the field of fertilizer production, why not call Dorr-Oliver for a preliminary discussion, or write for information to Dorr-Oliver Incorporated, Stamford, Connecticut?

The services of Dorr-Oliver cover all phases of plant design, from economic analysis to flowsheet preparation, construction, supply and installation of equipment and supervision of initial operation.



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efficiency and 95-105 F. It produces 14 lb./hr. periodic acid which goes to oxidize corn starch in a separate vessel.

Cat cracker goal: Up high-value output

Unicracking—Union Oil of Calif.'s new catalytic hydrocracking process to make high-quality gasoline out of low-quality distillate fuels—is just a short step away from commercialization. Company reports that three months of data-gathering in a 4-8 bbl./day pilot plant have been completed. And, though construction-start date has yet to be set, complete designs for a large-scale plant have been drawn up. Furthermore, Union plans to license the process to interested firms.

While company is chary about revealing process' details, features cited for Unicracking indicate it's probably very similar to Cal Research's recently unveiled Isocracking (*Chem. Eng.*, Nov. 16, p. 106). Both claim greater than 100% yields, absence of low-value cracked fuel oil byproducts, simplicity and flexibility of operation. And key to Unicracking, as to Isocracking, lies in an unidentified long-life rugged catalyst. Declares Union, Unicracking catalyst need not be regenerated continuously, instead will run for several months followed by short regeneration periods.

Coincidence that, within short weeks of each other, two California firms should independently come up with similar processes for similar applications is explained by the fact that West Coast refiners traditionally face the problem of having too much low-value middle distillate stocks and fuel oil.

But refiners elsewhere in the U.S. face very much the same problem, are working chiefly on cat-cracker-feed preparation schemes to solve it. At the AIChE meeting in San Francisco earlier this month Texaco revealed that it has installed furfural extraction units to upgrade virgin feedstocks to cat crackers at two refineries, so reduce fuel oil output. And Kellogg, at the same meeting, revealed that studies on a 5-bbl./day pilot plant show that phenol extraction of cracker feed results in 7-10% more gasoline output.

Truck brings fuel plant to rocket site

Faced with the difficult task of transporting huge rocket motors from manufacturing plant to isolated missile launching pads, North American Aviation's Rocketdyne Div. has de-

cided to transport the manufacturing plant to the launching pad instead.

To turn this trick, company has engineered a continuous solid propellant process, dubbed Quickmix, that can be carried from rocket site to rocket site on a truck trailer, and can turn out one of several propellant formulations as it travels along. In way of demonstrating this striking portability, Rocketdyne recently transported a 500-lb./hr. Quickmix plant on a 30-ft. truck trailer from Santa Susana, Calif., to McGregor, Tex. Now plans call for a 5,000-lb./hr. facility.

A high-speed and impressively safe process, Quickmix can be used to make most known solid propellants on a continuous basis. And it can be easily changed from one formulation to another, Rocketdyne maintains.

Whatever oxidizer is to be used is first dried, sifted and ground, then dispersed in a liquid carrier. Dry fuel ingredients, including metal powder, are similarly handled. Fluid propellant ingredients, such as binder materials, enter the system through a colloid mill. There they are emulsified with the liquid carrier streams. Propellant formulation is completed in a high-speed mixer.

Device to measure pulsating gas flow

One answer to the question of how to accurately measure pulsating gas flow has been supplied by Tokyo University professor Takashi Isobe. He has invented a device that goes far in eliminating the 50%-and-greater errors in flowrates that often result when measurements are taken with presently available instruments. Patented in Japan and manufactured there by Hokushin Electric Works, Isobe's instrument is now in successful commercial operation at the ammonia synthesis plants of Bofu and Nissana Chemical.

Problem the Isobe device attacks: The fact that, while pulsating flowrate varies as the square root of instantaneous pressure differential across an orifice plate, orifice-plate meters in the usual measuring instruments read only the average pressure differential.

Isobe's measuring technique depends on the fact that the same pressure differential exists across an orifice in an "auxiliary" stream outside the main stream as exists across the main-stream orifice itself.

Pulsating pressure on either side of the main-stream orifice is transmitted to the same respective positions across the auxiliary-

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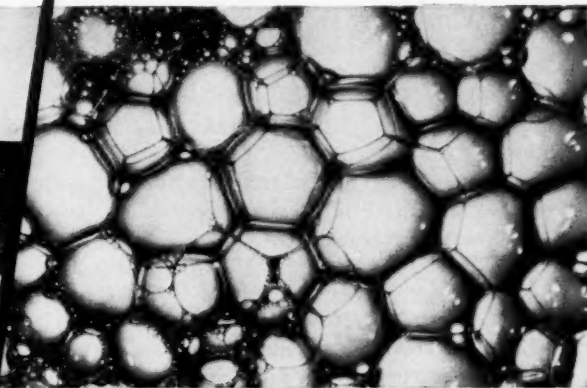
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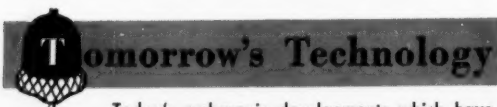
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FOOD GRADE, 75%
N.F., 85%



stream orifice via polystyrene membranes. Steady auxiliary stream flow—Isobe's device uses clean, dry air—simulates main stream gas flow but is at a much lower rate through the smaller auxiliary-stream piping.

Auxiliary flow is controlled by position of upstream transmitting membrane with respect to a nozzle that bleeds off part of the auxiliary stream. Measurements are taken on the auxiliary stream by either a displacement gas meter or an orifice-differential transmitter-recorder. The two streams are linearly proportional throughout the flow range.



Today's embryonic developments which have special significance for chemical engineers

Which way from heat to electricity?

Three exotic transducers to convert heat into electricity are now searching for power-generating jobs in space craft, submarines and in home lighting.

- Magnetohydrodynamic power, based on the potential difference generated by passing thermally ionized gas through a magnetic field, is being groomed for space-craft power packets by General Electric (*Chementator*, Nov. 30, p. 24). Now Avco-Everett Research Labs (Everett, Mass.), under the sponsorship of ten electric power utilities in the Ohio River valley, reports that it has started a development program aimed at harnessing this technique to the job of generating public power.

- Lightweight (220-lb), minature nuclear reactor has been successfully test-operated by the Atomic Energy Commission as part of its SNAP (Systems for Nuclear Auxiliary Power) program, reportedly shows promise for use as a power supply in space vehicles. Designed and built by Atomics International, the unit is a sodium-cooled reactor. When coupled to a mercury boiler and a mercury-vapor-driven turbine, developed by Thompson Ramo Wooldridge, it produces 3 kw. of electricity. Too, AEC has an undescribed homogeneous reactor under development in the SNAP program for submarine auxiliary-power generation, *CE* learns.

- Portable generators to be hooked to thermoelectric converters and single-crystal rectifiers are now under construction for the Navy by Carrier Corp. and Westinghouse.

Generators will be air cooled, weigh no more than 25 lb., burn kerosene or gasoline. Coupled to the thermoelectric device or rectifier, units will be designed to turn out 5,000 watts of d. c. power, operate at roughly 15% efficiency.

Big atomic-desalting unit proposed

Fluor Corp., which played a key role in the nuclear-desalination plant slated for Point Loma, Calif. (*Chementator*, Nov. 2, p. 22), has now come up with the most ambitious scheme to date for harnessing nuclear energy to the job of making fresh water from the sea.

Company has set a detailed proposal before Interior Dept.'s Office of Saline Water that calls for a mammoth 50-million-gal./day, 52-stage flash evaporation plant hooked to a 370-thermal-megawatt pressurized-water nuclear steam generator providing 627,000 lb./hr. of 240 F. saturated steam.

Fluor estimates cost of reactor would be \$11.5 million; cost of seawater-conversion plant, \$30.7 million. Payoff on this hefty investment, Fluor declares, would be production of fresh water of less than 100 ppm. (TDS) from seawater of over 35,000 ppm. (TDS) at the impressively low cost of 42¢/1,000 gal.

Oil well waters: Source of minerals?

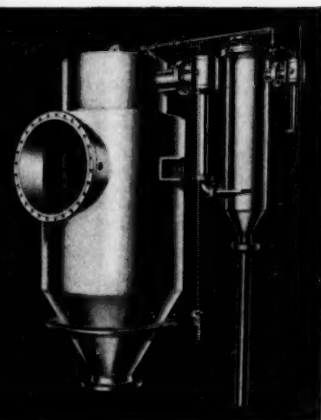
Just-released study by the Alberta (Canada) Research Council indicates that the formation waters of oil wells could be rich sources for a host of minerals and inorganic chemicals. Reports the Council, these waters often contain a greater concentration of materials such as magnesium, bromine, calcium, iodine, sodium, chlorides, carbonates and sulfates than do brine wells or seawater.

So far, Michigan Chemical is only firm known to be tapping this mineral source. It's recovering bromine from Murphy Corp.'s Eldorado, Ark., oil field (*Chem. Eng.*, June 2, 1958, p. 51).

In the Redwater oil fields north of Edmonton, Council notes, formation waters contain about 6 lb./bbl. of magnesium—roughly 12 times the concentration of seawater. And they contain about 0.5 lb./bbl. bromine—nearly 20 times that of seawater. Amount of magnesium that could be recovered from the Redwater field is put at 462,000 lb./mo.; amount of bromine, 48,400 lb./mo.

For more on DEVELOPMENTS 78

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Maleic-Phthalic Race Breeds New

Rush to build new maleic and phthalic capacity has created a demand for improved processes. Here is a roundup of who is doing what in this turbulent field.

Out of the furor of new plant announcements, price cutting and process claims in the maleic-phthalic field, at least two facts are emerging: (1) Despite dire predictions of overcapacity in maleic by 1961, every company involved is steaming ahead with its project for new capacity; (2) After a 20-year shake-down period, the fluid-bed route to phthalic anhydride is becoming truly commercial.

In maleic anhydride, the market resembles a gigantic poker game being played for high stakes—and every player is keeping his cards close to his vest. Several rounds of betting have gone by and now the participants are starting to show their hands. What appeared to be bluffs—maleic-fumaric price cutting by Allied and Monsanto in the face of a tight market—haven't worked. In spite of this attempt to scare off new producers, every announced project for new maleic capacity (with the single exception of Heyden Newport) is now under way, underlining an apparent widespread faith in the future potential of maleic anhydride.

Attempting to bring the whole maleic-phthalic picture into sharper focus, *CE* has assembled all available information on new plants and processes and brings it to you in this package.

► **Markets Create Technology**—In maleic and phthalic, market potential has been setting the technological pace; there is no

single technical "breakthrough" behind all the activity.

Driving force behind the maleic boom is the healthy growth pattern for polyester and alkyd resins that utilize maleic anhydride; e.g., for reinforced plastics and surface coatings. Now produced at around 65 million lb./yr., consumption is estimated at 100 million lb./yr. by 1961—considerably below the available capacity, however.

Two maleic processes, both based on fixed-bed oxidation of benzene, are the major market factors: the Scientific Design and Badger Mfg. processes. The SD process will soon be operating in five commercial plants and SD has just announced three new contracts (see below). Badger's process is offered on sub-license from Reichhold Chemicals and will be used in Oronite Chemical's new 20-million-lb./yr. plant in Richmond, Calif. Badger is also building Reichhold's new maleic plant at Elizabeth, N. J.

► **Ditto for Phthalic**—Sizable growth prospects for phthalic-consuming materials (alkyd resins and plasticizers) stimulated the three new phthalic anhydride plants. But because the additional capacity is only a small fraction of the estimated 600 million lb./yr. phthalic capacity, the situation is not as hectic as in maleic.

Three entirely different processes are being used at these new facilities. At Chicago, Ill., Witco Chemical is using the traditional

fixed-bed, vapor-phase naphthalene oxidation approach.* Developed by Scientific Design, process Witco is using is said to employ a new catalyst plus design improvements to increase yield and product purity (see below).

Amoco Chemicals at Joliet, Ill., is using the much-heralded liquid-phase xylene oxidation process to produce phthalic anhydride plus other dibasic acids. It was Amoco that triggered a round of price-cutting in phthalic last year before its plant was on stream but has been unable to make any deliveries because of startup difficulties.

► **Fluid-Bed Comes of Age**—The new Reichhold phthalic plant at Elizabeth will employ a fluid-bed process, marking the first time in the U. S. a phthalic producer has bought a fluid-bed plant on the open market.† After the well-publicized troubles this process has had, the conversion of a fixed-bed producer to this approach is a real milestone.

Reichhold will use the modified Sherwin-Williams process offered by Badger Mfg. Co. and already operating at S-W's 6-million-lb./yr. plant. Reichhold cites several operating advantages as reasons for making its choice. Fluid-bed reactor requires no molten salt heat transfer medium, eliminating need to inventory salt and

* Oronite is the only producer to use essentially the same flowsheet to oxidize ortho-xylene to phthalic.

† Sherwin-Williams and American Cyanamid developed their own processes.

Processes

keep it purified. No naphthalene vaporizer is needed, the molten naphthalene being injected directly into the reactor. Finally, fluid-bed design lends itself better to large units; Reichhold has provision in its new plant for expansion to 50 million lb./yr. Reichhold emphasizes that yield increase—often touted as fluid-bed's big advantage—was not the only reason for picking this process.

► **Trend to Fluid-Bed?**—American Cyanamid has independently developed its own fluid-bed process for phthalic manufacture at Bridgeville, Pa. While freely admitting that it took around eight years to get the plant to operate satisfactorily, Cyanamid says now the unit is operating at twice design capacity and is achieving yields "so high that no one will believe us."

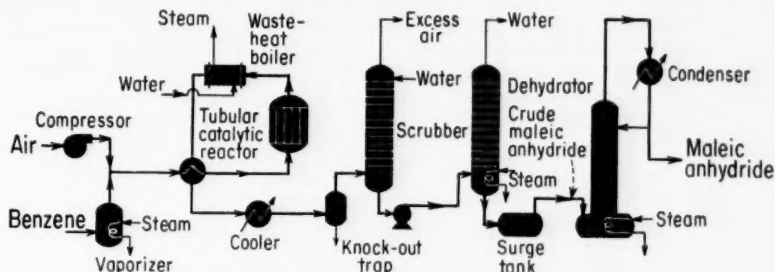
Without describing any details, Cyanamid says its process differs in many respects from the Sherwin-Williams process and has been granted several patents. Cyanamid has no plans at present for licensing the process.

Cyanamid, which also produces phthalic by the fixed-bed route, is thoroughly sold on the virtues of fluid-bed. Besides higher yields, Cyanamid points to easier purification of products, faster catalyst change (one day vs. 2-3 weeks) and greater safety. Lower air-to-naphthalene ratio reduces explosion hazards while presence of fluid catalyst "stone dusts" the reaction, further reducing possibility of explosion.

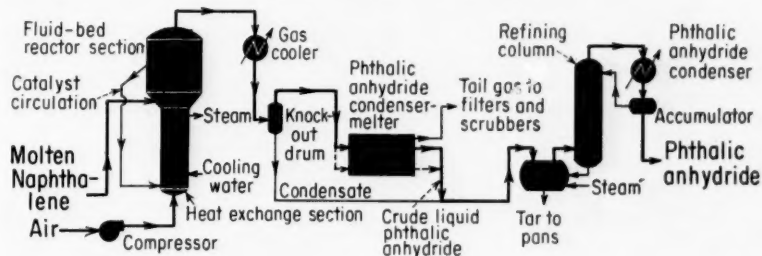
Here is a brief rundown on the maleic-phthalic processes in use today:

► **Scientific Design Maleic Anhydride Process**—Just coming on stream at American Cyanamid's 20-million-lb./yr. plant at

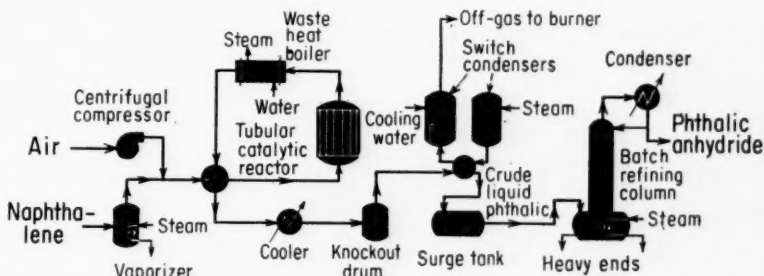
Scientific Design Maleic Anhydride Process



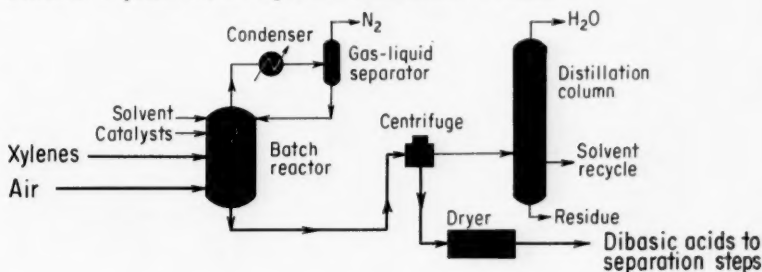
Badger Fluid-Bed Phthalic Anhydride Process



Scientific Design Fixed-Bed Phthalic Anhydride Process



Amoco Liquid-Phase Xylene Oxidation Process

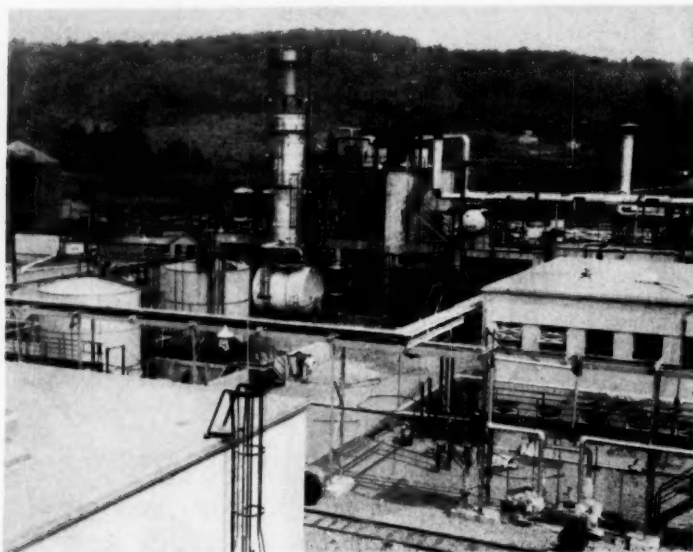


Bridgeville, Pa., the SD process relies on a relatively standard flowsheet, depends on its own catalyst and engineering refinements for selling points. SD has just announced three new maleic anhydride contracts: Monsanto

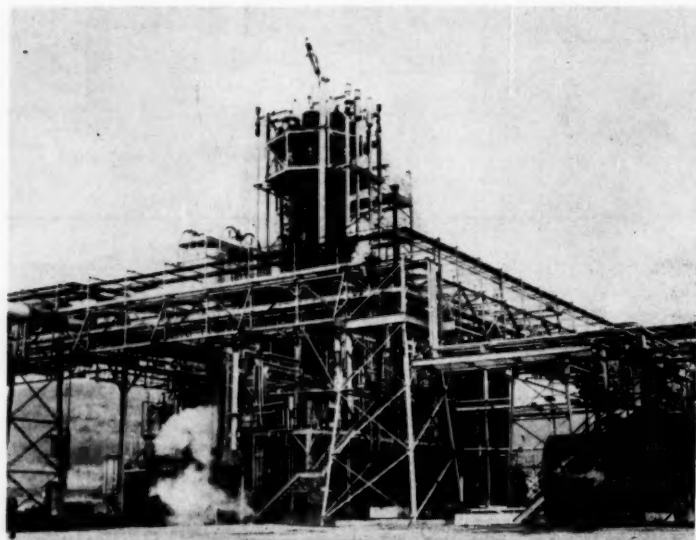
Chemical, St. Louis, Mo., Pittsburgh Coke & Chemical, Neville Island, Pa., and Monsanto of Canada, Ville La Salle, Que.

SD's novel—but unidentified—catalyst is claimed to give "the highest yields in the industry."

American Cyanamid Displays Two U. S. "Firsts"



MALEIC ANHYDRIDE plant, slated to be in production by first of the year, uses the SD process—first SD maleic plant on stream in this country.



PHTHALIC ANHYDRIDE plant uses firm's own fluid-bed process. After a series of startup troubles, unit is reported to be operating over capacity.

While no figures are given out, one industry estimate pegs yields at somewhere just over 80%.

Besides the Cyanamid plant, process is already employed in two foreign plants, one in France and one in Italy. SD also did some revamping of Reichhold Chemicals' existing maleic plant at Elizabeth, N. J. And SD is just finishing up a turnkey 15-million-lb./yr. maleic plant for Monsanto Chemicals, Ltd., at Newport, Eng. The series of maleic jobs firm is doing for Monsanto is a real feather in SD's cap since Monsanto already had its own proprietary process before it switched to the SD version.

► **Badger Fluid-Bed Phthalic Anhydride Process**—Licensed from Sherwin-Williams, process employs a modified vanadium pentoxide catalyst. Badger says its main contributions consist of improved reactor design, improved condensing and recovery techniques plus improved purification system.

According to the literature, process uses an air-to-naphthalene ratio of less than 15:1, with reactor operating at about 700 F. Catalyst circulates from reactor to a heat exchanger where reaction heat is removed as steam. Fluid bed allows close control of reaction temperature and avoids catalyst hot-spots which lead to formation of maleic anhydride.

Capital cost, according to Badger, is around \$250 per annual ton of capacity. Operating and maintenance costs are claimed to be lower than comparable fixed-bed units because of lower air requirements and lower labor requirements. Yields are claimed to be "5-10% greater than average fixed-bed processes" which would put it around 95%.

Besides the Reichhold unit, Badger is also building phthalic plants for Montecatini in Italy and Union Chimique Belge in Belgium.

► **SD Fixed-Bed Phthalic Anhydride Process**—Scientific Design's new phthalic process is getting its first tryout in Witco's \$3.5-million, 20-million lb./yr. plant in Chicago.

While based on a standard flowsheet, process has two novel

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Here's the Latest Maleic-Phthalic Boxscore

Company-location	Product	Process	New Capacity (MM lb./yr.)	Status
Allied; Moundsville, W. Va.; Buffalo, N.Y.	Maleic	Proprietary fixed-bed	Est. 10	In startup
Allied; Moundsville, W. Va.	Fumaric	Proprietary fixed-bed		Startup June '60
Am. Cyanamid; Bridgeville, Pa.	Phthalic	Proprietary fluid-bed	40	Full production
Am. Cyanamid; Bridgeville, Pa.	Maleic	SD fixed-bed	20	In startup
Amoco; Joliet, Ill.	Dibasic acids	Liquid-phase xylene oxidation	60	In startup
Heyden Newport; Fords, N. J.	Maleic-fumaric		24	Planned
Monsanto; St. Louis, Mo.	Maleic	SD fixed-bed	20	Construction starting
Oronite; Richmond, Calif.	Maleic	Badger fixed-bed	20	Startup June '60
Pittsburgh Coke; Neville Island, Pa.	Maleic	SD fixed-bed	20	On stream 1961
Reichhold; Elizabeth, N. J.	Phthalic	Badger fluid-bed	30	Startup Jan. '60
Reichhold; Elizabeth, N. J.	Maleic	Proprietary fixed-bed	20	On stream fall '60
Utah Resin; Salt Lake City	Maleic-fumaric	Proprietary fixed-bed	2.4	In startup
Witco; Chicago, Ill.	Phthalic	SD fixed-bed	20	60% production

aspects: a new catalyst and improved process design. Catalyst, identified no further than "containing vanadium," is said to give yields "substantially over 80%," reportedly in the 85-90% range. The high yields are said to simplify the refining steps and give a purer product. Too, there is said to be some novel engineering in the design of the switch condenser system, but no details are available.

Although onstream announcements have appeared, the Witco plant has encountered some start-up trouble and at last report was operating at only 60% of capacity.

► **Amoco Liquid-Phase Xylene Oxidation Process**—Little is known about the Amoco process beyond the basic process chemistry (*Chem. Eng.*, June 15, 1959, p. 71). Essentially, it is a method for converting alkyl aromatics to aromatic carboxylic acids (of which phthalic acid is only one) in a single step. Specifically, Amoco's plant at Joliet will utilize the process to oxidize mixed xylenes to a wide range of dibasic acids. Advantage of this approach is the ability to use a mixed feed and the flexibility to tailor product range to market demand—reportedly at lower cost than any other process.

Operating as a batch process, air oxidizes the xylene mixture in presence of a heavy metal and some form of bromine as a catalyst at 255-525 F. and 1-40 atm. Reaction time is 0.5-3 hr.

Amoco is having its own share of startup problems—doubly painful because of its premature phthalic price cutting. Company reports that some of the plant's units are operating, but full production has not been achieved; only product shipped to date has been dimethyl terephthalate. (Industry observers believe that most of Amoco's woes are originating in the separation section.)

In Japan, the same process is being used by Mitsui Petrochemicals to oxidize para-xylene to terephthalic acid. Originally rated at 15 million lb./yr., Mitsui's plant was recently doubled, both jobs being engineered by Scientific Design. Maruzen Oil also has a similar plant under construction in Japan. And in England, SD is doing the design and engineering for a 30-million-lb./yr. terephthalic acid plant for Imperial Chemical Industries that will use para-xylene.

► **Proprietary Processes** — All processes currently used for making fumaric acid (the stereoisomer of maleic acid) are based on proprietary knowledge. There are three basic routes: (1) recovering fumaric from waste liquors from phthalic production, (2) oxidation of benzene to make fumaric along with maleic acid, (3) fermentation of molasses. The only producer using the fermentation process is Bzura Chemical—but it also processes phthalic liquors.

Among producers who oxidize

benzene to fumaric are Allied Chemical and the newly formed Utah Resin Corp. (*Chem. Eng.*, Oct. 19, 1959, p. 98). Allied says it is installing a "new" process at Moundsville, W. Va., to make maleic and fumaric, but will reveal no further details.

Utah Resin's plant at Salt Lake City which is just coming on stream has a 2.4 million lb./yr. capacity (maleic and fumaric) which is slated for captive use. Process employs a new vanadium pentoxide catalyst with three unidentified "promoters" which give yields of about 85% based on benzene.

The Utah Resin plant is being watched with keen interest by others in the field because of its attempt to produce maleic and fumaric economically from such a small plant. If Utah Resin can do it successfully, it may pave the way for other consumers to build their own small production units.

Reportedly one of the design companies quoted a price of \$1 million to build the Utah Resin plant. But through company-originated shortcuts, URC says it has pared the capital cost down to \$60,000 (see p. 69).

On another front, Oronite reports that it has modified its well-known ammonia-sulfur process (isophthalic acid from meta-xylene) to produce terephthalic acid from para-xylene. Switch required only minor changes in the purification step, says the company.



IN THE **100,000-GPM Bracket**

When cold water requirements reach six-figure proportions, plant surveys suggest that selection of Marley Class 600 cooling towers is becoming a custom. The reason is "economic amplification" . . . as physical structure enlarges, so do Class 600's tangible and intangible advantages become progressively more important.

Consider the years that Class 600 structure adds to amortization period. Engineered for inherent durability, it has the added years-spanning protection of inert materials used at critical points throughout.

Class 600's longitudinally manifolded end-inlet distribution provides economy that increases with every foot of tower length.

Multiplied by the number of fan cells, the plus value of Marley engineered-for-the-job

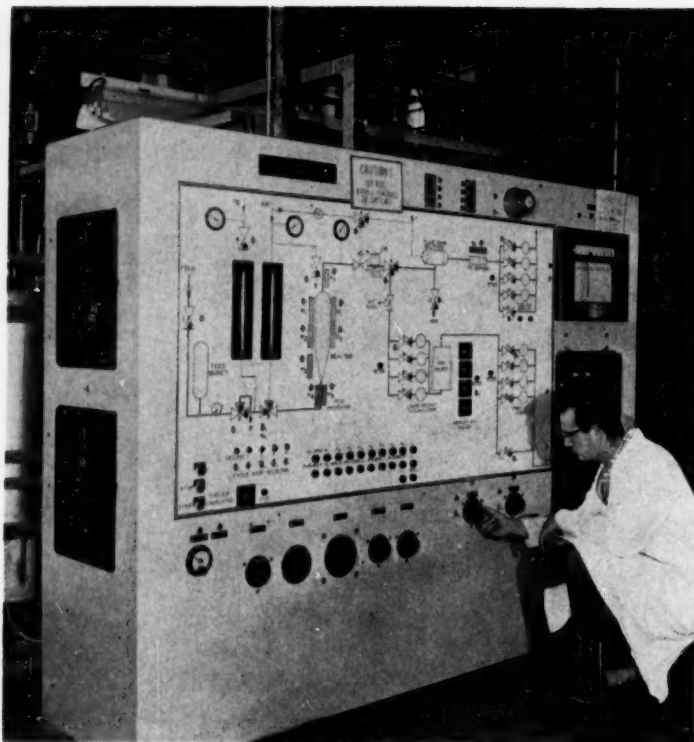
mechanical equipment and vibration-free fans is most imposing.

Marley's development of specialized equipment to facilitate service operations assumes realistic proportions when days (rather than hours) are conserved.

Performance? It is generally accepted as an established fact that a Marley Class 600 Cross-Flow tower will meet or exceed specified performance. Results of consecutive tests published annually emphasize the validity of this conclusion.

These are only part of an impressive list of factors that qualify Class 600 towers for highest standing in the largest capacity field. And every one is prominently present in every Marley Cross-Flow, whether it be a one-, four- or forty-cell tower.

THE MARLEY COMPANY  KANSAS CITY, MISSOURI



CONTROL of catalyst, feed studies need minimum manpower.

Lab Automates Test Cracker

Automated fluid unit boosts efficiency four-fold on feed and catalyst evaluations.

To test characteristics of both feed and catalyst samples, California Research Corp. is operating an automated pilot-scale fluid catalytic cracking unit which gives four times more output (in terms of completed analyses) per operator man-hour. Three automatic timers program all functions and the sequence of operations.

One unique arrangement, and probably the key to superior performance, is that Cal Research has made one timer a "slave" to another, which means the latter dictates to the former exactly what to do. Cal Research won't reveal just how this is done, but

does say that the arrangement gives six additional check points for sampling and control.

► **Can Do Three Jobs**—Unit can perform three services: Testing cracking characteristics of feed oils, measure catalyst characteristics, evaluate catalyst ageing. It checks such feed oil characteristics as refractivity (a measure of extent to which an oil will crack), product distribution and quality of product, such as octane and sulfur content. On catalysts, it tests activity and selectivity. Complete catalyst evaluation is done in 6 hr., with two cycles including distillation. Catalyst ageing involves alternate cracking

and regenerating; unit runs indefinitely with only occasional refilling of feed storage cells.

Unit has reactor capacity of about 2,000 cc., and is designed to operate up to 1,200 F. and 50 psig.

► **Frees Manpower**—Formerly, such testing required constant attention of an operator, was tedious and slow. Now an operator spends only two to four hr./day for two catalyst evaluations. He charges unit in the morning, picks up sample near the end of the shift and recharges for night run. He then picks up sample in the morning.

Cb Flotation Process Looks Good in Tryout

Kennecott Copper Corp. is working on a process that may be the key to unlocking the vast amounts of columbium now tied up in the low-grade pyrochlore and perovskite deposits on the North American continent. Kennecott describes the new columbium flotation process—utilizing 8-quinolinol flotation reagent—in U. S. Patent 2,875,896. Company says process has proved successful on a pilot scale and a decision is pending on whether it will be tried out in a commercial plant.

If the process gets the go-ahead, it will mark the birth of a columbium mining industry in North America; Kennecott has long been interested in Canadian Cb ores and now has the technical know-how to start a commercial venture. Most of the columbium metal produced in this country now comes from foreign columbite ores that can be concentrated by gravity, electrostatic or magnetic methods. These methods, however, do not work on low-grade Cb minerals. Flotation has not been practical up to this time for the lack of a suitable flotation reagent.

In test results on an upgraded ore pulp containing 2.36% Cb_2O_5 , Kennecott obtained a concentrate with 9.72% Cb_2O_5 with an 88% recovery. Most of the expensive flotation reagent can be reclaimed.

Processes & Technology continues on page 86.



A Y Globe that challenges comparison shows it pays to

Specify JENKINS for STAINLESS STEEL Valves, too

Want the "best buy" in Stainless Steel Y Globe Valves? Compare this Jenkins Fig. 1335 with any on the market. You'll conclude that it's hard to beat Jenkins at making valves, no matter what the material.

You'll find genuine superiority of design and construction in the features shown here. But no picture can show the quality of the castings . . . the precision machining . . . the rigid inspection and testing that have gone into this valve. All of these are as important as design and metal alloys in assuring

long, dependable, economical valve service. And, all of them are up to the peak standards for which Jenkins has been known for almost a century.

SEND FOR NEW CATALOG of Jenkins Stainless Steel Valves, in patterns and alloys that satisfy the requirements of practically all corrosive services.

These Jenkins Valves meet valve industry specifications and the high standards established by leading users of stainless steel valves.

WHEEL of high strength malleable iron designed for firm grip and easy operation.

SPINDLE of large diameter and dense structure has high resistance to wear and torsion strains. Easy, tight closing is assured by long, precision machined thread bearing surfaces. A beveled shoulder provides backseating against inside of bonnet, permitting repacking under pressure.

PACKING A Teflon ring in large packing box prevents leakage. Only a minimum load is required on gland, extending service life of packing.

DISC HOLDER, held by lock nut, has depth equal to disc thickness, preventing flow of plastic disc. Wide disc retaining nut covers all but seating surface of Teflon disc.

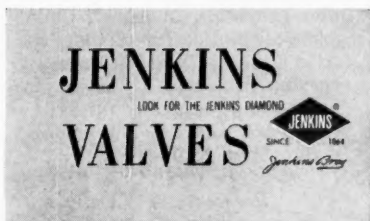
DISC is Teflon made by Jenkins

YOKE BUSHING, easily renewable. Made of bronze, for ideal thread engagement with stainless steel spindle, to prevent seizing or galling of spindle threads. Bushing of stainless steel is optional.

YOKE BONNET, a single unit, has liberal space between yoke arms for easy access to packing box. Tongue and groove joint with body makes a pressure-tight seal with less tightening on the bolts, and eliminates possibility of blowing out the Teflon gasket.

GLAND consists of two pieces — gland flange and gland follower — to prevent binding of follower in case gland bolts are tightened unevenly. Crowned surface of flange secures tightness against gland without excessive tightening of gland nuts.

BODY Through-port design for full, free flow. Liberal seat height permits repeated refacing. Cast on body are directional arrow and bosses for drain connections. End flanges conform to M.S.S. specifications.



Sold Through Leading Distributors Everywhere



JENKINS BROS., 100 Park Avenue, New York 17, N. Y.

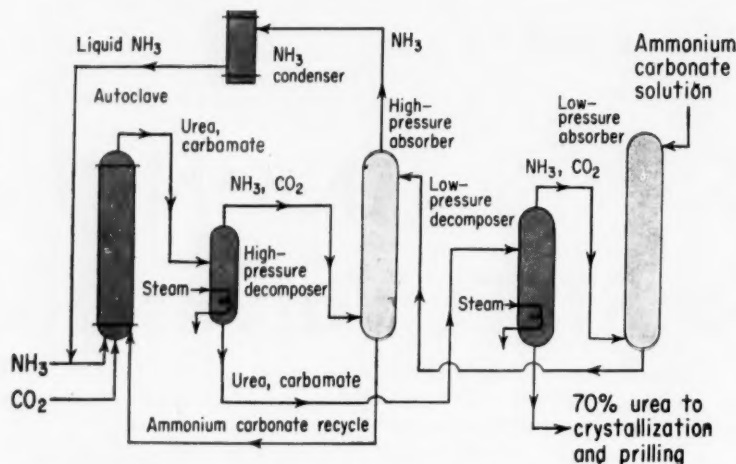
☐ Send the new stainless steel valve catalog

NAME & TITLE.....

☐ Have a representative call on me

COMPANY.....

ADDRESS.....



ABSORBERS scavenge NH_3 and CO_2 with ammonium carbonate.

Another Urea Process Bows In

Novel NH_3 - CO_2 absorption system enables new process to exploit advantages of liquid recycle.

Now bidding for the attention of world urea makers are the new Toyo Koatsu urea processes currently in operation in five plants in Japan, accounting for 418,000 annual metric tons of capacity. Offered in three versions (zero, partial or total recycle), most unique of the three is the total recycle flowsheet (*Chem. Eng.*, Nov. 16, 1959, p. 92).

Like the Montecatini and Pechiney processes, the Toyo Koatsu total recycle process employs a liquid recycle, eliminating the need for separating unreacted ammonia and carbon dioxide. But unlike Pechiney and Montecatini, Toyo Koatsu absorbs the NH_3 and CO_2 in ammonium carbonate and pumps this liquid stream back to the autoclave.

► Reaction Conditions—Used in Toyo's 66,000-metric-ton/yr. plant at Chiba, Japan, the total recycle process operates at 355 F. and 3,200 psig. Molar ratio of NH_3 to CO_2 in the feed is 3.5:1. Under these conditions, conversion in the autoclave is 57-58%.

Autoclave effluent of urea,

water, carbamate and excess NH_3 passes through an expansion valve to the high-pressure decomposer. Ammonia and CO_2 pass overhead to the high-pressure absorber while the urea-carbamate solution flows to the low-pressure decomposer where remaining carbamate is decomposed to NH_3 and CO_2 .

Aqueous urea solution from the bottom of the low-pressure decomposer contains 70% urea plus small amounts of NH_3 and CO_2 . These gas traces are removed in a gas separator and are treated with water to form the ammonium carbonate scrubbing solution that feeds to the top of the low-pressure absorber.

► How to Minimize Biuret—Toyo Koatsu also employs a novel prilling technique to give strong, low-biuret, low-water prills. Instead of evaporating urea to 99.5% as in most processes—with resulting biuret formation—evaporation is stopped at 90% and solution sent to a crystallizer. Resulting crystals can then be dried to the desired water content and conveyed to the top of

the prilling tower where they are remelted and put through the prilling heads. Prills made this way have a maximum biuret content of 0.5% with 0.3% moisture and can be stored without coating. Too, says Toyo Koatsu, this method eliminates problem of urea sticking to inner walls of the prilling tower.

Smog War Centers on Los Angeles Battle

Air Pollution Foundation, San Marino, Calif., stepped up its attack on atmospheric olefins last month. It disclosed that formaldehyde and acrolein—both photochemical reaction products of olefins—are responsible for eye irritation and blurred visibility. Foundation, whose work centers on the west coast smog problem, previously asserted that olefins—from auto exhaust and industrial-plant vapor loss—must be eliminated in large part to solve that problem. Los Angeles Air Pollution Control District has enunciated several rules whose enforcement should eliminate 90% of plant vapor loss.

► Cut Car Wastes—There is pressure to eliminate the other large olefin source—auto exhaust products. The Pollution Control District rules that gasoline cannot be sold that exceeds a limiting olefin content.

And efforts are being made to cut down olefins formed by combustion. L.A. County Board of Supervisors has set standards for auto antimog devices: cost less than \$100, operate at 80% efficiency for 25,000 miles.

One promising device is the Thompson Ramo Wooldridge-Chrysler afterburner. A combination heat-exchanger and reactor, this device eliminates more offenders (80-90% efficient) at less cost (probably \$125) than other proposals. Although Griswold Smith, director of the Pollution Control District, recently reported that the TRW-Chrysler device should be ready for 1961-model-year cars, Automobile Dealers Assn. denies it.

Processes & Technology continues on page 88.

TITANIUM—COMING OF AGE!



Spray dryer wheels get longer life from titanium

Titanium is chalking up large savings as a material for process industries equipment. Its corrosion resistance, strength and light weight, and easy machinability all add up to economies.

For example, the atomizer wheels, as shown above, are vital components in spray dryers manufactured by Bowen Engineering, Inc., North Branch, N. J. They turn at selected speeds between 6000 and 20,000 rpm, blasting feed liquid into fine spray to be dried by heat.

In one installation, a titanium wheel operated 2200 hours in hot calcium hypochlorite. With previously used materials the entire wheel had to be replaced after this service but only the outer basket of the titanium wheel needed replacement. In addition, the light weight of titanium greatly reduced wear on bearings in this high speed rotating part, producing further savings.

To learn more about titanium, in new, profitable applications, write us. We can show you how this light,

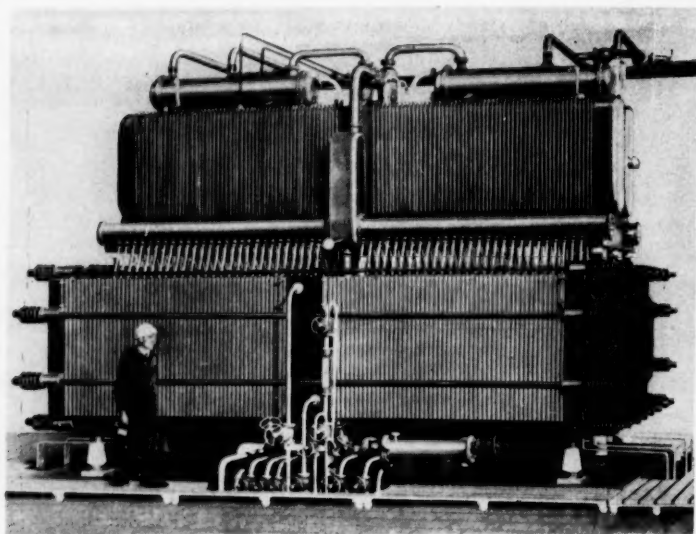
strong, corrosion-resisting metal is coming of age as an economical answer to difficult corrosion problems.

Union Carbide Metals Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. In Canada: Union Carbide Canada Limited, Toronto.



**Electromet Brand Ferroalloys
and other Metallurgical Products**

The terms "Electromet" and "Union Carbide" are registered trade marks of Union Carbide Corporation.



ELECTROLYZER and accessories dwarf this De Nora engineer.

Giant Electrolyzers Produce H₂

World's largest water-electrolysis plant, soon to go on stream, employs custom-designed De Nora cells to produce H₂.

Now nearing completion is the world's largest water-electrolysis hydrogen plant under construction by Vitro Corp. for Nangal Fertilizer and Chemicals (private), Ltd., in northern India. Giant 880,000-cu. ft./hr. hydrogen plant consists of sixty of the world's largest electrolyzers, each one 24 ft. long, 18 ft. high and rated at 10,000 amp.

Hydrogen plant is key part of a \$60-million processing complex, to synthesize ammonia, produce nitrophosphate fertilizer and isolate deuterium. Electrolyzers, custom designed by De Nora, Milan, Italy, will enrich hydrogen in deuterium for feed to a Linde hydrogen-distillation plant (*Chem. Eng.*, Feb. 23, 1959, pp. 68-72).

Each electrolyzer consists of a battery of 100 or more bipolar cells, clamped together in a filter-press configuration. Thus, bus bars and linkage to end electrodes are the only electrical connections

required. Electrodes are perforated mild-steel plates; anodes are nickel-plated to prevent attack by oxygen.

Key cell innovation is the double asbestos diaphragm between electrodes, to prevent even slight mixing of oxygen and hydrogen products. Hydrogen purity is critical in operation of the adjoining hydrogen-distillation plant, fed by the cells. Gases leaking into intermediate compartment, formed by the diaphragms, vent to the atmosphere. And double diaphragm minimizes the danger of explosive hydrogen-oxygen mixtures in the event of diaphragm failure.

In normal cell operation, hydrogen and oxygen accumulate in plenums next to the electrodes. Product gases discharge from respective plenums into separator drums, then through submerged nozzles into bubble compartments, both on top of the electrolyzers. Separator drums remove

entrained electrolyte from rising product gases; bubble compartments maintain uniform gas pressure in the electrolysis system despite surges in gas.

Both hydrogen and oxygen gases then rise through overhead scrubbers, countercurrent to cell-feed-water flow. Scrubbing further enriches in deuterium the feed to the hydrogen distillation plant by removing traces of deuterium from other effluent gas streams; total pre-enrichment amounts to 900 ppm. of D₂O.

Pulp Cyanoethylation Improves Paper Quality

Acrylonitrile has found a new place in the pulp and paper industry. By a new technique, developed by General Electric, paper with better dielectric properties is now produced.

Technique is an offshoot of long-used cyanoethylation of cotton to produce moisture-resistant fibers. First to use the new paper-modifying technique is Hollingsworth and Vose Co., East Walpole, Mass. By alkaline hydrolysis followed by acrylonitrile esterification, HV modifies the pulp's cellulosic structure.

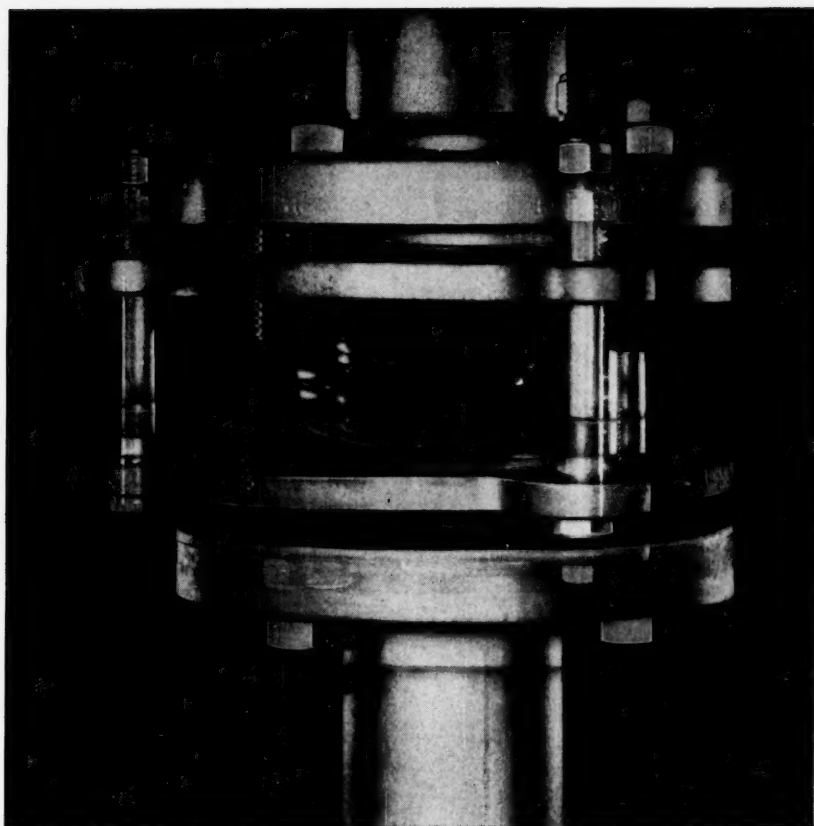
Cyanoethylated pulp makes paper with higher acid resistance, greater dimensional stability and better dielectric properties. General Electric now buys HV's special paper for transformers.

CE's Computer Census Cited by AIChE

Last Tuesday at the San Francisco AIChE meeting, W. M. Carlson of Du Pont described first-year activities of the Institute's Machine Computation Committee.

Quoting CE's computer census (*Chem. Eng.*, Sep. 7, 1959, p. 127), Carlson said that duplication of computer-programming effort is reason enough for promoting program interchange in the CPI. Programs most needed are those for statistical, design and production studies.

Processes & Technology
Continues on page 90.

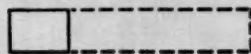


MOLDED DESIGN



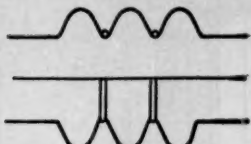
rounded interior convolutions,
extra thickness at stress points

HIGH TENSILE STRENGTH



Teflon at its best, Fluoroflex-T
provides at least 300% elongation

METAL REINFORCING RINGS



permit greater travel from
shorter units, prevent distortion
from surges

2 MILLION CYCLES AND STILL FLEXING!

*...proving that this Teflon expansion joint—molded of Fluoroflex-T
—outlasts most other materials and constructions*

Chemical manufacturer: Tried Fluoroflex®-T joint, found it *still flexing* after 2 million cycles; previously had averaged 100,000 cycles from machined Teflon® flex joint in pumping application.

Major industrial product company: Displaced one end of a special Fluoroflex-T bellows ¾-inch from its axis, rotated it around axis at 1,000 rpm. After 20 million cycles, with still no sign of deterioration, test discontinued.

Petrochemical processor: Installed Fluoroflex-T joints to replace joints machined from Teflon. The Fluoroflex-T joints are still in service after nearly a year.

Fluoroflex-T flex and expansion joints perform so much better for three reasons: (1) *The material:* a patented compound of Teflon that com-

bines high density with low crystallinity for optimum strength and flexibility. (2) *The process:* a unique technique for molding uniform convolutions with restraining rings. This gives undamaged grain structure, rounded interior convolutions and increased strength. (3) *The experience:* Resistoflex has been working with fluorocarbon resins since their inception. For fabricating with Teflon, such experience is *vital*. That's why Fluoroflex-T is Teflon at its best.

So, for corrosion-proof flex and expansion joints that give unsurpassed working life, specify Fluoroflex-T. Write for Bulletin B-1A. Dept. 303, RESISTOFLEX CORPORATION, Roseland, N. J. Other Plants: Anaheim, Calif.; Dallas, Tex.

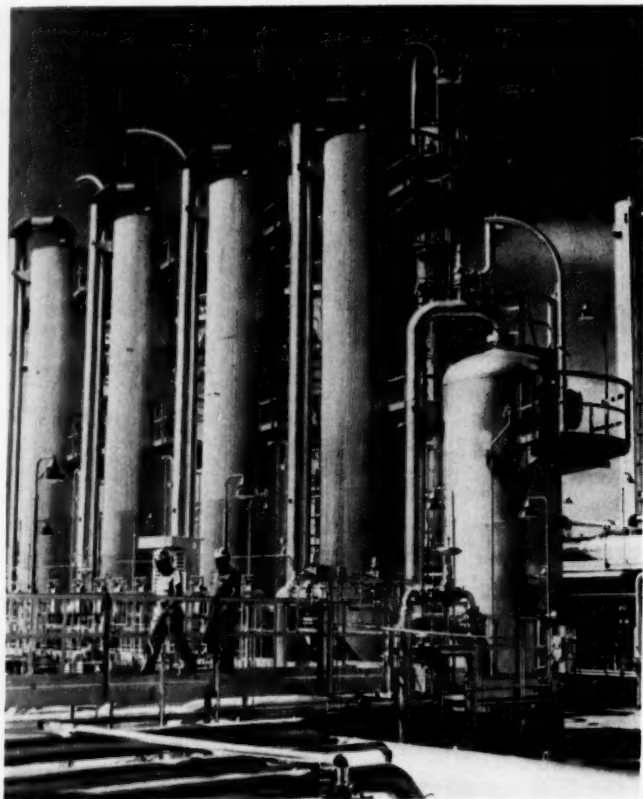
®Fluoroflex is a Resistoflex trademark, reg., U. S. pat. off.

®Teflon is DuPont's trademark for TFE fluorocarbon resins.

Complete systems

for corrosive service

RESISTOFLEX



Oklahoma Plant Doubles U. S. Helium Output

To meet U.S.'s soaring helium demands, Bureau of Mines has swung on stream its fifth and, by far, largest helium plant. Located at Keyes, Okla., the \$12-million facility built by Fluor Corp. extracts 290 million cu. ft./yr. 99.995%-pure helium from 50 million cu. ft./day natural gas. Now BuMines is considering plans to build 12 more helium plants. To be placed

strategically along natural gas pipelines, these units would salvage some 3 billion cu. ft./yr. helium now being lost as natural gas flows directly to fuel markets. Nation's helium needs—for military, industry and hospital use—have climbed fivefold in last ten years, will continue rising even more steeply in decade ahead, predicts Bureau of Mines.

NEWS BRIEFS

Beryllium oxide: Commercial production of 99.99% purity beryllium oxide from domestic low-grade beryl ore is now under way by Mineral Concen-

trates & Chemical Co. at Loveland and Berthoud, Colo. To date, oxide has been produced only from the much-scarcer high-grade ore deposits in U. S. or imported from Africa, South America and India. To

handle low-grade deposits, company says it has developed a new chemical extraction process.

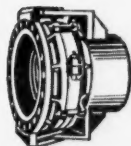
Cracking catalyst: Socony Mobil has developed a Heavy Dura-bead cracking catalyst with 25% higher flowing density than regular beads, allowing substantial reduction in size of moving-bed cat cracking units and regenerators. Heavier density could boost regenerator capacity by as much as 80%. High selectivity and attrition resistance permit catalyst temperatures up to 1,125 F. with no loss of selectivity, should cut makeup requirements by more than 50%, according to Socony.

Fusion power: Los Alamos Labs, among the pioneers of the widely-publicized pinch effect, reports it's now working on a promising new approach to control thermonuclear energy. It's called entropy trapping, involves changing hydrogen fusion plasma from an ordered (low-entropy) to a disordered system, then trapping plasma in a magnetic bottle. To do this, lab uses a hydromagnetic gun and a pair of magnetic coils referred to as a picket-fence magnetic bottle. Combination gets denser, cleaner plasma, has contained plasma in preliminary tests for 200 microseconds. Energy from plasma appears as low-grade heat in cooling coils around and in the unit's magnetic coils.

Acid glass: Glascote Products, Inc. is offering an exceptionally high-acid-resistant glass for lining process equipment. Called Glascote 778, material reportedly withstands attack of 15-75% nitric up to 400 F., 8-20% hydrochloric up to 400 F., 80% sulfuric up to 450 F. At same time, company notes, alkali, abrasion and thermal-shock resistance has been maintained at a high level. Though unwilling to disclose composition, Glascote says that new glass doesn't contain boron as does lab glassware whose acid-resistant properties it rivals.



Free-Flexing Expansion Joints



Hinged Expansion Joints



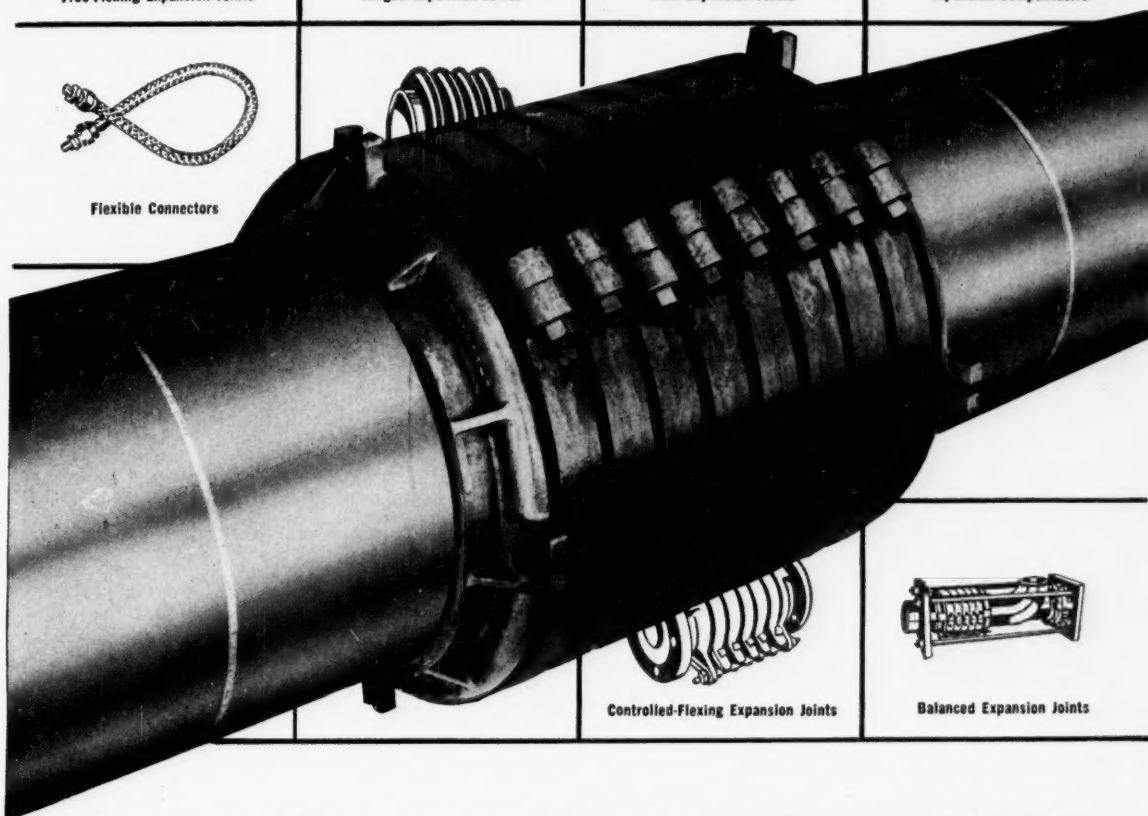
Dual Expansion Joints



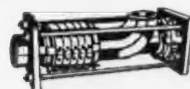
Expansion Compensators



Flexible Connectors



Controlled-Flexing Expansion Joints



Balanced Expansion Joints

THE COMPLETE LINE TO TAKE CARE OF ANY KIND OF PIPE MOTION

Flexonics has the equipment — as well as the experience and the skill — to take care of any kind of pipe motion problem. Here's where you benefit from more research . . . more metallurgical care . . . more service . . . and now standard stock sizes for quick delivery from Flexonics warehouses. They all add up to expansion joints that you can *install and forget* — plus ex-

pansion compensators, flexible connectors, and the all-new Flexonics pipe alignment guides—to take care of any kind of pipe motion!

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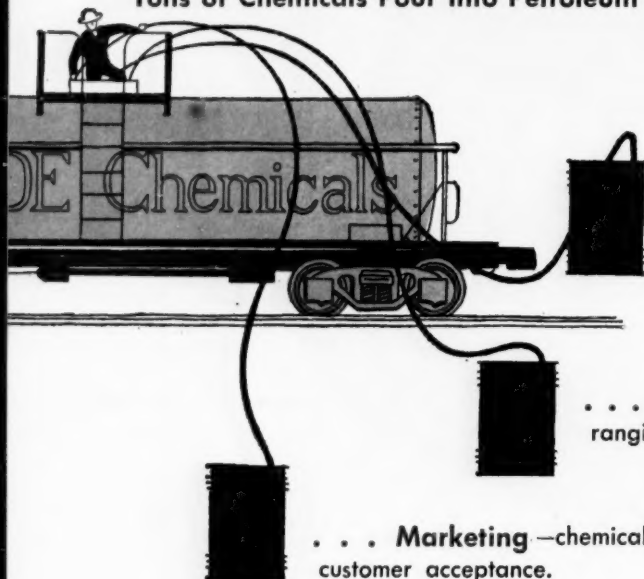
Divisions

INDUSTRIAL HOSE • EXPANSION JOINT • BELLOWS • AERONAUTICAL • AUTOMOTIVE

Flexonics Research Laboratories, Elgin, Illinois

In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario

Tons of Chemicals Pour Into Petroleum Industry for . . .



. . . **Production**—as wells plunge deeper, drilling muds need more chemical bolstering.

. . . **Refining**—chemicals cope with problems ranging from high octanes to air pollution.

. . . **Marketing**—chemical additives boost customer acceptance.

Are YOUR Chemicals Being Used?

It takes chemicals to produce petroleum and petroleum products. Chemicals are increasingly needed, are increasingly helpful, in getting oil out of the ground, splitting it at the refineries into many useful product streams, putting both an icing on, and a deep-down usefulness into, the final products.

A good horseback estimate of chemical volume would be well over 2 million tons/yr. But bulk is only part of the story. Sales of many of the specialty chemicals—dyes, stabilizers, antioxidants, etc.—add up to something like \$500 million, or more than all the big-volume chemicals put together.

Of all areas of the petroleum industry, drilling probably uses the greatest volume of chemicals—primarily in order to put drilling muds together. As wells go deeper—this year the industry sank 230 wells of 15,000 ft. or more—drilling temperatures and pressures go higher, and drilling muds must work harder and harder. Enter better chemical systems, particularly those which will be unaffected by contaminants at extreme conditions.

► **Make It Thick**—About 95% of all barium sulfate produced goes into drilling muds. In fact, barite accounts for nearly one-half of the total cost of all mud materials, and more volume

than all other additives combined.

Over 700,000 tons of clays are used in drilling muds as sealers, viscosity promoters and suspension agents. Bentonite is still the principal clay used, although it is losing some ground recently due to increased emphasis on oil-in-water emulsions and low-solids muds.

Fuller's earth, another popular clay, is employed principally in salt-water muds where bentonite is not as effective.

The market for low-yield clays—mostly calcium montmorillonite mixed with soda ash—runs about 47,000 tons/yr.

► **Make It Thin**—For the job of viscosity reduction, complex



ACRYLATE MONOMERS

Looking for something?
Yes. A bump on a base line.

What would that mean?
Presence of contaminating fractions in acrylates.

Found any?
Not in our Celanese acrylate monomers.

So what does it prove?
High purity!

Does that do anything for me?
High purity of our monomers means reduced induction periods. The pure monomer polymerizes at a uniform rate, gives a high conversion of monomer to polymer.

Sounds good!
Products are made better . . . and made easier

Such as?
Emulsions for paints, paper, leather, adhesives, and textiles.
Used as chemical intermediates, too.

Mind if I take a peek?
That's what I brought them along for.

We'd do the same for any customer, wouldn't we? And more. We'd even tell the kind of acrylates we make: methyl, ethyl, butyl, and 2-ethylhexyl. The properties, polymerization, inhibition, storage, handling, and shipment of Celanese acrylate monomers is a story in itself. It's all wrapped up in a neat bulletin which is yours for the asking. Write today for "Celanese Acrylate Esters." Celanese Chemical Company, a Division of Celanese Corporation of America, Dept. 553-L, 180 Madison Ave., N. Y. 16, N. Y.

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Celanese
CHEMICALS

phosphates such as sodium tetraphosphate are kept busy to the tune of 10 million lb./yr. Phosphate use, however, will probably fall off by 1963 because these compounds don't stand up well at high temperatures and can only be used with fresh-water muds.

Modified lignosulfonates, on the other hand, show fast growth potential as drilling-mud thinners. Introduced in 1957, lignosulfonates are already racking up sales of 25 million lb. this year.

Quebracho has a steady market in thinning—35 million lb.—with about 35,000 tons of caustic soda being used, in conjunction, to reduce acidity. Hemlock extract is increasingly used as a drilling-mud thinner.

► **Stop It Up**—Carboxymethylcellulose (CMC), synthetic poly-

mers and cornstarch improve sealing properties of muds. Natural gums, particularly guar gum, are used in lesser amounts. Use of CMC, stable to 350 F., is spreading at the expense of cornstarch which doesn't stand up under high temperatures and is subject to bacterial degradation above 250 F.

Synthetic polymers like hydrolyzed polyacrylonitrile—on the market only since 1957—find greater use in high temperature lines (350-400 F.) as thickness controllers.

Nonionic surfactants have been one of the brightest developments in drilling mud additives since 1955. Their biggest advantage, heat stability, puts them into low-solids, oil-emulsion muds, in order to maintain low viscosity and low water loss, and into high-weight muds, to

control the solids-carrying capacity of the muds.

► **To Foam or Not to Foam**—Bulk of the foam-inhibitor market in muds is held by alkyl aryl sulfonates, with sulfonated castor oil being used more and more in some operations.

Chemicals which produce foams are also incorporated in drilling muds for drilling via gas injection. (Foam is used to remove water and cuttings from the drill hole.)

Specialty drilling-mud additives include flocculants, corrosion inhibitors, extreme-pressure additives and emulsifying agents. Flocculants separate drilled solids at the surface and eliminate the need for water thinning.

Use of extreme pressure additives is increasing; they cut drilling time 12-25%, increase bit life as much as five-fold. Emulsion muds need emulsifying agents such as sodium salts of tall oil or sulfonated hydrocarbons. Some nonionic surfactants are used as emulsifiers, as well as lignites, CMC, tannins and cornstarch.

More than 70% of all money spent on drilling muds goes into the Gulf Coast Region; over 80% of the total mud market is accounted for by but 20% of the wells.

So expensive have these muds become that there has been a trend in recent years toward reclaiming mud and renting it. Nevertheless, the outlook is for steadily growing mud-chemical markets as more and deeper wells are drilled.

► **Product Additives**—At the other, or product, end of the petroleum industry, chemicals get in theiricks as additives for fuels and lubes.

Future of many gasoline additives depends on the changing demand for automotive and aviation fuels. For example, U.S. refiners spend at present about \$277 million/yr. on antiknock chemicals for auto fuels, about \$38 million on aviation gasoline.

Chemical additives for motor gasoline (mainly phosphorus in the form of tricresyl phosphate) help control combustion chamber deposits. It's estimated that 30% of all gasoline marketed on the East Coast contains a

Chemicals That Help the Petroleum Producer

	Function In Drilling Mud	Consumption (Tons/Yr.)
Barium sulfate.....	Increase density	1,100,000
Clays.....	Sealers, viscosity promoters, suspension agents	717,000
Bentonite.....		600,000
Fuller's earth.....		70,000
Low-yield clays.....		47,000
Lignites.....	Thinners, emulsifiers	28,000†
Cornstarch.....	Filtration retarder (sealer)	25,000†
Quebracho.....	Thinner	18,000
Modified lignosulfonates.....	Thinners	13,000
Carboxymethylcellulose.....	Filtration retarder (sealer)	8,000†
Sodium tetraphosphate, other complex phosphates.....	Thinners	5,000
Hemlock extract.....	Thinner	5,000
Synthetic polymers.....	Filtration retarders (sealers)	1,000-1,500
Nonionic surfactants.....	Maintain low viscosity and water loss	1,000-1,500
Paraformaldehyde.....	Starch preservative	1,250
Graphite.....	Extreme-pressure additive	1,200
Sulfurized derivative of tall oil.....	Extreme-pressure additive	1,200
Sodium salts of tall oil, sulfonated hydrocarbons, etc.....	Emulsifying agents	1,150†
Calcium chloride.....	Shale stabilizer	1,000
Gypsum.....	Shale stabilizer	1,000
Sodium pentachlorophenate, phenol, cresol.....	Starch preservatives	750
Alkyl aryl sulfonates, sulfonated castor oil.....	Foam inhibitor	300
Sodium chromate and dichromate, for the most part.....	Corrosion inhibitors	200
Surfactants, nonionic and anionic.....	Foaming agents	100*

* Includes nonionic agents listed elsewhere; † includes nonionic surfactants, lignites, CMC, tannins and cornstarch listed elsewhere.

NaH Uses Up!

.....

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MHI announces price reduction of over 20% for Sodium Hydride Oil Dispersion

This new price schedule may well justify your switch to sodium hydride for most condensation and alkylation reactions requiring a base! The new lower price of sodium hydride oil dispersion coupled with its reaction effectiveness and ease of handling merit your investigation.

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10,000 pounds and over* — \$.95 per pound . . . 1,000 pound quantities — \$1.00 per pound . . . 100 pound quantities — \$1.25 per pound . . . Up to 100 pounds — \$2.25 per pound . . .

*In one year.

NaH applications include:

Metallation and alkylation of amines and amides. — Fast reaction that results in high yields . . . especially useful for synthesising tranquilizers and antihistamines. Phenothiazine and 2 amino pyridine, for example, are rapidly alkylated.

Glycidyl Ester synthesis — through Darzen's condensation NaH

simplifies these reactions and brightens the future of glycidyl esters in flavors and perfumes. NaH successfully permits the condensation of ethyl chloroacetate and acetophenone, cyclohexanone, and methyl nonyl ketone.

Alkylation of Malonic-type Esters with Alkyl Halides — a low-temperature reaction that eliminates forcing techniques.

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PIONEERS IN HYDRIDE CHEMISTRY

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phosphorus-type additive, and that all premium gasoline will someday have such an additive.

Antitrust compounds feature a wide variety of chemicals: e.g. unsaturated organic acids, alkyl acid orthophosphates, amine and ammonium sulfonates, and fatty acid amines.

► **Stop Gum Formation**—There's a growing market for chemicals which can prevent gum formation in stored gasoline. Stability can be improved, of course, by washing with caustic or acid, by adsorption of impurities, by partial hydrogenation, but it is

often more economical to rely on an antioxidant.

Major gasoline antioxidants run up sales of \$6-7 million/yr. and include 2,6-di-tert-butyl-4-methyl phenol; N,N-di-sec-butyl-*p*-phenylene diamine; 2,4-dimethyl-6-tert-butyl phenol.

Metal deactivators are sometimes used in conjunction with antioxidants. Typical examples: N,N-disalicylidene-1, 2-diaminopropane; N,N-disalicylal ethylene diamine.

Control of deposits in auto-fuel injection systems may represent bigger markets for chem-

ical additives. So-called "oil-type" materials are now used in concentrations up to 0.5%; the "surface active" variety is effective at levels of about 12 lb./1,000 bbl. fuel.

► **Color Helps**—Gasoline dyes warn of toxic TEL content when fuel is spilled, and help distinguish between brands and grades. Four dyes that are used most: *p*-dimethyl-aminoazobenzene (yellow); benzene-azo-2-naphthol (orange); 1,4-dialkyl-amino-anthraquinone (blue); and methyl derivatives of azobenzene-4-azo-2-naphthol (red).

Nongasoline additives, pretty much limited to heating oils and diesel fuels in the past, have found new markets in jet-aircraft fuels. One additive—the corrosion inhibitor—is mandatory in military jet fuels; antioxidants and metal deactivators are optional. All three types of compound are optional in commercial jet fuels.

Sales of corrosion inhibitors for military jet fuels will increase from \$400,000 last year to \$539,000 in 1961. Sales of inhibitors for commercial jet fuel will zoom from last year's \$29,000 to \$217,000 in 1961.

Consumption forecasts for additives for jet fuel, heating oils, diesel fuels and lube oils will be found in the table on p. 98.

For more details on chemicals consumed by the petroleum industry, write on company letterhead for CPI Research Report No. 111-2, c/o Chemical Engineering, Market Research Manager, 330 West 42nd St., New York 36, N. Y.

Chemicals That Help the Petroleum Refiner

	Physical Refining	Chemical Refining	Maintenance
Non-Solvents			
Ammonia	Lube dewaxing, gas treatment	Alkylation	Corrosion inhibitor, refrigerant
Ethanolamines	Acidic-gas treatment	Polymerization	
Sodium hydroxide	Neutralization, sulfur removal	Alkylation	Equipment cleaning
Glycols	Gas dehydration, extraction, light-oil treating		
Calcium chloride	Lube-oil and wax processing, gas drying		
Hydrofluoric acid		Alkylation	
Chlorine	Gas treatment		
Sodium chloride	Drying agent		
Hydrochloric acid		Isomerization catalyst	Equipment cleaning
Sulfuric acid	Lube-oil acid treating	Sulfonation, alkylation	Scale removal
Consumption (Thousand Lb./Yr.)			

Solvents (lube-oil refining)	
Furfural	Refining.....9,200
Propane	Deasphalting, Duo-Sol refining.....26,080
Phenol	Duo-Sol refining.....12,150
Cresol	Duo-Sol refining.....4,780
Chlorex	Refining.....1,320
Nitrobenzene	Refining.....330
Ethylene dichloride	Barisol dewaxing.....69
Methylethyl ketone	Dewaxing.....7,200
Benzene	Dewaxing.....3,176
Toluene	Dewaxing.....6,100
Aluminum chloride	Alchlor dewaxing.....83
Sulfur dioxide (liquid)	Refining.....5,000

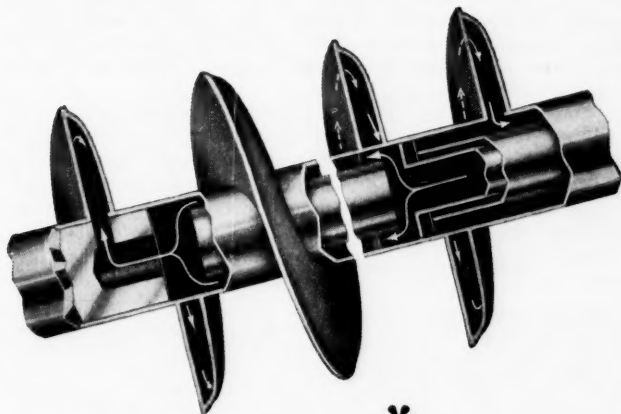
Chemicals That Help the Petroleum Marketer . . . p. 98

More Propane Means More Butane

We need more propane because butane is getting shorter. A contradiction? No, just a warning from G. W. McCullough, Phillips Petroleum executive, as he spoke before a fall meeting of the Natural Gasoline Assn. of America in Tyler, Tex.

"Many leading experts are forecasting a serious shortage of butane within the next five years," thanks to hopped-up demands on the hydrocarbon as a feedstock for chemical synthesis and for isomerization and alkylation processing at the

New savings in heat-exchange processes...



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A simpler, more compact way to cool, heat or dry—in continuous flow!

Do you have processes where slurries, solids, pulps or pastes must be cooled, heated or dried? Do you know you can now handle such processes—in continuous flow—in as little as 1/5th the space required by other types of heat exchangers—and with many other important advantages?

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what it is!

Basically the HOLO-FLITE consists of two or more flights of hollow-bladed screw conveyors. The product to be processed moves in a trough around the conveyor screws. The heat-transfer fluid circulates through the hollow blades and shafts of the conveyor. The product is constantly rotated into, around, under and over the blades and shafts through which the heat-transfer fluid is circulating, assuring quick, uniform heat passage between the two mediums—as the product is continuously moved along in a bulk-flow without interruptions!

Our engineers will gladly study your particular operations and make recommendations. Write, wire or phone our nearest office!



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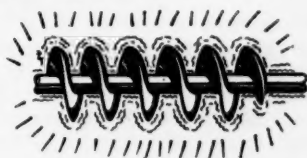
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why IT'S BETTER!

The HOLO-FLITE principle provides many important advantages in modern processing operations...



ITS LARGE HEAT-TRANSFER SURFACE requires far less space—as little as 1/5th the space required by other heat-exchange equipment. Further, flights can be "stacked" as high as desired to save floor space, simplify installation!



ITS SLOW ROTATION IS SO GENTLE that granular and powdered solids are handled with no dusting—little or no particle abrasion. Result—no dust recovery problems . . . simple, inexpensive installation.



IT IS ADAPTABLE to a wide range of applications—handles solids, pulps, pastes and slurries with equal ease. Heat transfer agent can be refrigerant, water or other fluids to provide a wide range of temperatures. Cooled products can be packed directly from HOLO-FLITE discharge, saving time, space and additional handling.



IT CAN BE DESIGNED to handle virtually any capacity by varying the diameter and length of the flights, and the number of "tiers."



FREE 8 PAGE bulletin describes Holo-Flite features and applications. Send for your copy!

crude oil refinery.

Chemical manufacture, including rubber components, already accounts for about 30% of all LPG sales, according to McCullough. And alkylation capacity is up 25-30 thousand bbl./day this year alone.

To the liquefied petroleum gas (LPG) dealers and customers using butane or a butane-propane mix as fuel—especially those in the South and South-

west—McCullough's advice is this: Switch to straight propane. This will assure them a more dependable fuel supply and will free butane for more specialized needs which might justify higher-than-fuel prices. (Domestic fuel markets already take 45-57% of all LPG sold.)

McCullough urges natural gasoline processors, on the other hand, to increase propane yields through more efficient

and more exhaustive extraction of natural gas. (Butane recovery is, of course, near the maximum.) He adds, however, that LPG prices will have to rise to make deeper extraction profitable.

Processors have already taken big strides in this direction. "Extraction levels, on the average, have increased from the 60-65% propane-recovery level in 1952-53 to today's 75-80%, with some plants going as high as 90%."

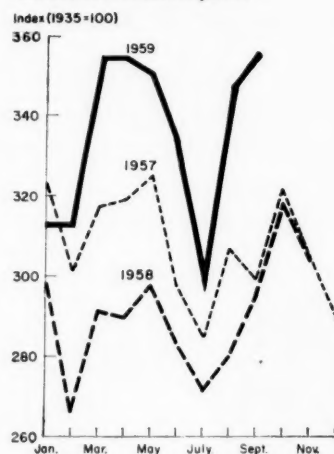
It's that last 10-20% propane fraction which is such a pivotal factor in chemical-feedstocks today.

"The plant of the present and the future will be designed for higher and higher propane recovery."

Chemicals That Help the Petroleum Marketer

	Consumption, Million Pounds		1960	
	1958		1960	
	Auto-	Avia-	Auto-	Avia-
	motive	tion	motive	tion
In Gasoline				
Antiknock agents				
Tetraethyl lead	455	57	485	43
Ethylene dibromide	133	33	141	25
Ethylene dichloride	139	.....	149	.....
Combustion-deposit modifiers (mainly phosphorus as tricresyl phosphate)	2.1	.....	2.5	.....
Antirust agents (include unsaturated organic acids, alkyl acid orthophosphates, fatty acid amines)	4.0	0.6	4.3	0.4
Antioxidants (include substituted alkyl phenols, amino phenols)	6.7	0.7	7.1	0.5
Metal deactivators (salicyl derivatives)—used with antioxidants	1.3	.....	1.4	.....
Dyes (mostly azo- and anthraquinone-type)	0.07	0.1	0.9	0.05
In Military Jet Fuel				
Corrosion inhibitors	0.6	.....	0.73	.....
In Commercial Jet Fuel				
Corrosion inhibitors	0.041	.....	0.25	.....
In Heating Oil				
Stabilizers	2.67	.....	2.79	.....
Metal deactivators	0.086	.....	0.090	.....
Corrosion inhibitors	2.35	.....	2.45	.....
Pour-point depressants	0.071	.....	0.077	.....
In Diesel Fuel				
Stabilizers	2.67	.....	2.79	.....
Metal deactivators	0.086	.....	0.09	.....
Corrosion inhibitors	2.35	.....	2.45	.....
Pour-point depressants	0.04	.....	0.047	.....
In Motor Oil				
Conventional detergent-dispersants	.....	1959	.....	.....
Viscosity-index improvers	.....	325	.....	.....
Oxidation and corrosion inhibitors	.....	160	.....	.....
Extreme-pressure additives	.....	100	.....	.....
Pour-point depressants (wax-aryl condensation products)	.....	60	.....	.....
Foam inhibitors (silicone polymers), dyes, etc.	.....	30	.....	.....
	.....	8	.....	.....
In Waxes				
	.....	100	.....	.....
In Industrial Lubricants (cutting oils)				
Sulfur-chlorine additives	.....	50	.....	.....
Other additives	.....	250-300	.....	.....
In Road Oils				
Antistrip additives	.....	6	.....	.....
Emulsifiers	.....	60	.....	.....

Chemical Consumption



Consumption by Industries

	March (Final)	April (Final)	May (Final)
Coal products	11.0	10.9	10.7
Explosives	10.5	12.4	11.5
Fertilizer	88.4	85.9	80.7
Glass	27.6	28.9	29.1
Iron & steel	21.2	20.7	21.3
Leather	4.2	4.5	4.7
Paint & varnish	36.2	41.1	41.6
Petroleum ref.	33.1	30.7	31.6
Plastics	34.6	31.7	33.9
Pulp & paper	40.8	41.9	41.8
Rayon	28.1	28.4	27.2
Rubber	8.2	6.8	6.3
Textiles	11.1	11.0	10.3
Total	355	355	351

Held down "impossible" job for months vs. days

They were asking the "impossible" at this big West Coast mine. The hose used in their big beneficiation plant must be tough enough to handle the flow of murderously abrasive iron-ore slurry. Yet it still must be flexible enough to follow a twisting, bending course down from the top of the seven-story structure.

So it's little wonder their first hose sprang numerous leaks almost immediately — was finished completely in about 45 days. It wasn't until the G.T.M. — Goodyear Technical Man — recommended his special ore-carrying hose that they got satisfactory service.

In fact, the G.T.M.'s hose has been so successful that the company's purchased over 4,000 feet of it to date.

It's been on the job over 12 months now — completely mastering this extra-tough job.

So once again, the G.T.M. has proved that the "impossible" often boils down to right hose — and the right recommendation. Make sure you get both — by contacting your Goodyear Distributor — or writing Goodyear, Industrial Products Division, Akron 16, Ohio.

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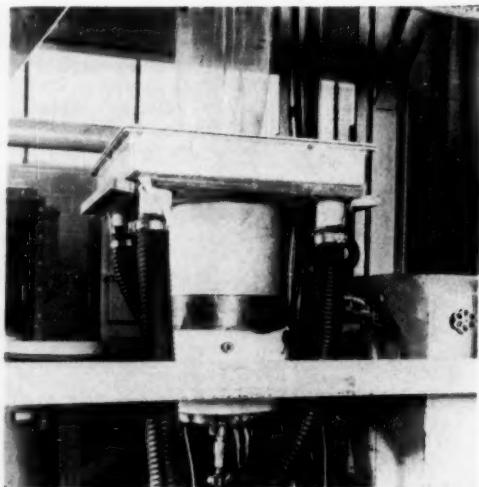
IT'S SMART TO DO BUSINESS with your Goodyear Distributor. He can give you fast, dependable service on V-Belts, Hose, Flat Belts and many other industrial rubber and non-rubber supplies. Look for him in the Yellow Pages under "Rubber Goods" or "Rubber Products."



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Tubular polyethylene film with substantially improved clarity and gloss can be produced at virtually no additional cost by means of a simple annealing chamber, photograph at left. Simple, inexpensive materials, such as wood, glass or insulated metal, can be used in fabricating this simple annealing device.

Secret of the increased clarity (right eyeglass lens) is in the fact that the film frost line is raised by chamber annealing. Height of the chamber is a critical factor in obtaining optimum film properties. Best results are noted when a chamber between 6 and 10 in. high is used.—U. S. Industrial Chemicals Co., New York. 100A

Emulsifiers

Emulsifiers for pesticides called universal.

A new emulsifier pair promises to vastly simplify inventories and formulations for formulators of toxicant systems. Called Toximul R and Toximul S, this pair will emulsify all of the pesticide types such as weed killers and chlorinated and phosphate insecticides. And better results are claimed for them than with the specific emulsifiers used heretofore.

Cited particularly is the emulsification of chlorinated toxicants in heavy aromatic sol-

vents, 2,4-D and 2,4,5-T esters, parathion, methyl parathion and phosdrin. Accelerated storage tests have shown that Toximul R and Toximul S are stable even in the most reactive systems.

Another emulsifier development is Toximul LF, a universal emulsifier for soil insecticides and other toxicants in most liquid fertilizers. This simplifies inventory and formulation for the compounding of one-shot liquid fertilizers and pesticides. Because of the very low moisture content, less than 1%, Toximul LF provides exceptional storage stability to the emulsifiable concentrate. — **Stepan Chemical Co., Chicago. 100B**

Curing Agents

Permit first 100% epoxy spray coatings.

For the first time a 100% solids epoxy coating can be applied with conventional spray equipment because of new hardeners, Epon curing H-1 and Epon curing agent H-2.

These agents provide controlled reactivity, require no heat to effect curing, are not adversely affected by high humidity and, when used with a liquid epoxy resin base, do not present a fire hazard.

Prior to this development the liquid epoxy base and the cur-

Section VIII
General Information

Section IV
Bulk Storage of Hydrogen Peroxide

Section V
Dilution of Hydrogen Peroxide

Section II
Stability of Hydrogen Peroxide

Section VII
Analytical Procedures

Section I
Properties of Hydrogen Peroxide and Its Aqueous Solutions

Section III
Hydrogen Peroxide Shipping Containers and Their Unloading

Section VI
Safety Precautions

Figure 52 - Hydrogen Peroxide Dilution System

Figure 13 - Nomograph for Determining Density of Various Concentrations of Hydrogen Peroxide Between 0 and 100 °C

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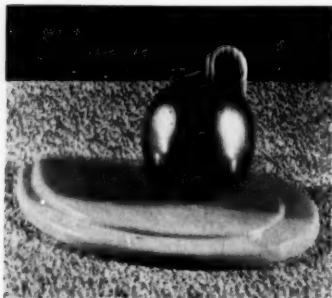
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ing agent either had to be mixed in small batches having a usable life of only 15 to 20 min., or required complex special spray equipment which metered the components and mixed them just prior to atomization. Now large batches may be mixed which have far longer usable working life so that ordinary spray guns may be used without danger of being clogged.

Use of the new hardeners with solvent type coatings based on higher molecular weight resins will provide a usable pot life of several weeks compared with a life of about one day when previously available curing agents are used. — **Shell Chemical Corp., N. Y.** 100C



Resin-Rubber

10-Lb. steel ball rebounds from resin twice as rigid as nylon.

Intended for use in precisely engineered products, the resin-rubber blend called Kralastic MM has good impact resistance, high rigidity and heat resistance.

A medium-impact plastic, lab tests indicate it is more rigid and has less tendency to creep, or flow, under load than any thermoplastic material now being marketed. Its rigidity is about twice that of nylon, and its resistance to creep is four times greater.

It is already in production, and is being evaluated or used for business machine housings, blades for home fans, data bloc assemblies for electronic brains, gears, squirrel-cage type blowers.

The new plastic has low moisture pick-up, good impact

strength and high abrasion and corrosion resistance. It will withstand heat, while maintaining usable strength, up to 200 F. It is available in a range of colors; molded parts have good gloss. Quantity price is 50¢/lb. — **United States Rubber Co., New York.** 102A

Vinyl Latex

First producer goes into exterior-wood paint field on full commercial basis.

A new PVAc latex, called Flexbond 800, just introduced for exterior use over wood is said to equal many of the technical advantages of acrylic latexes recently introduced for the same purpose. Practical advantages include lower cost, greater ease of manufacture and formulation. As with the acrylic paints, an oil primer is recommended for use over bare wood, formulations are not high gloss.

In contrast to other vinyl latex emulsions, Flexbond 800 requires no additional plasticizer and yields a permanently flexible film because it is a copolymer emulsion with plasticizing properties built in.

The new compound is higher in molecular weight than any other commercially available

PVAc emulsion. As a result, its films are outstanding for shock resistance, inherent toughness, and low temperature flexibility. Exceptional water resistance is also claimed. A completely saturated polymer, Flexbond 800 is relatively unaffected by ultraviolet light or heat.

Paints made with it would be about 55¢/gal. less than those made with acrylic resin and saving would be entirely in the cost of the resin. — **Colton Chemical Co., Cleveland.** 102B

Fibrous K₂TiO₃

Now available in insulating blankets.

Commercial production of low-density insulating blankets of Du Pont's fibrous potassium titanate in standard thicknesses from ¼ to 2 in. by 22 in. square at an average density of 16 lb./cu. ft. has been announced.

Fibrous potassium titanate has shown exceedingly low thermal conductivities up to temperatures of 2,200 F. Insulating properties are due in large measure to an extremely high refractive index of the crystalline fibers which serve to block infrared radiation by diffuse reflectance. Compacts of the fibers, such as are now being produced commercially, offer very high resistance to heat

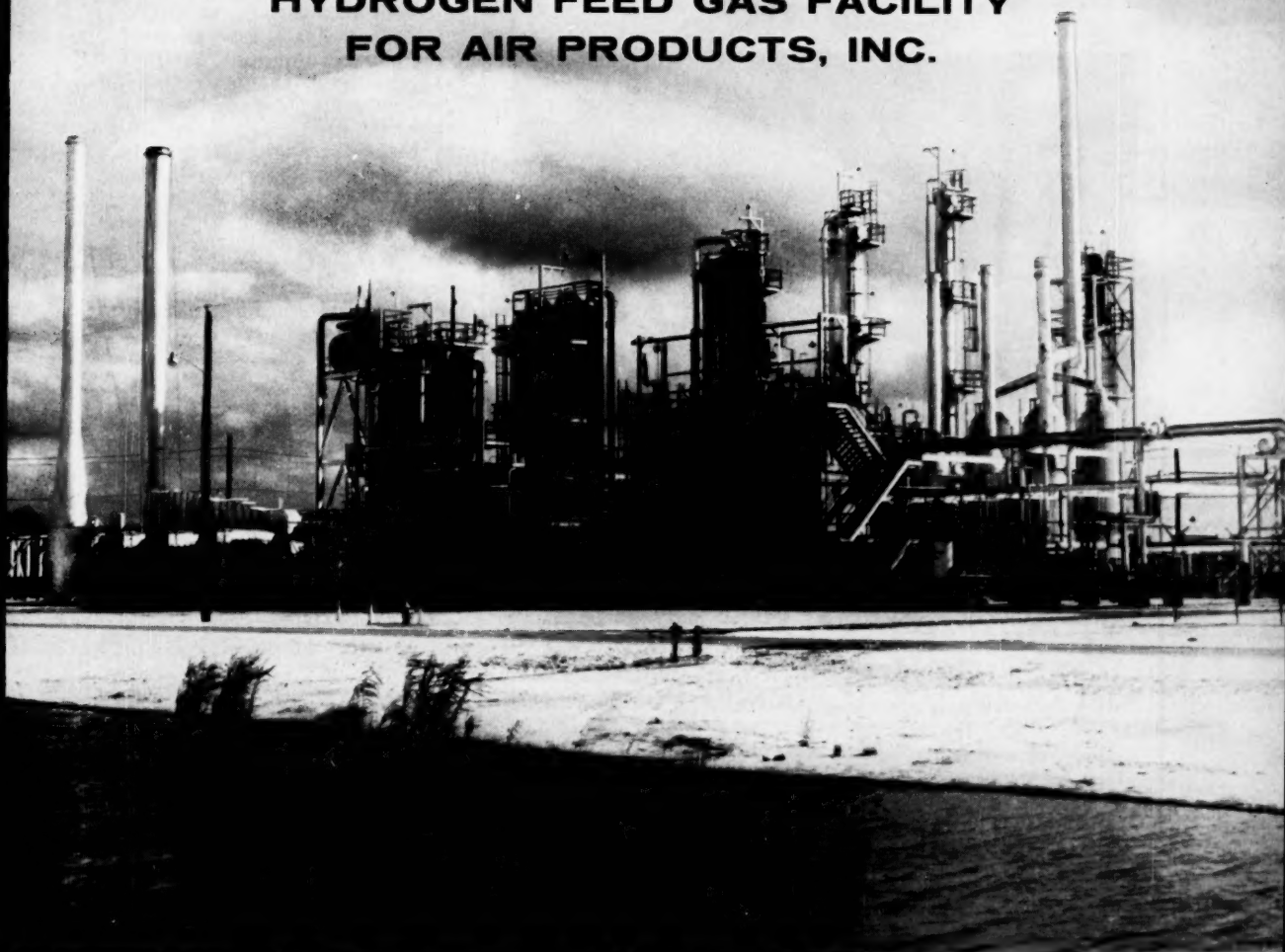
Newsworthy Chemicals

Page Number is also
Reader Service Code Number

Clearer polyethylene film via special annealing.....	100A
Emulsifiers handle wide array of pesticides.....	100B
Curing agents simplify epoxy spraying.....	100C
Resin-rubber is rigid and resists creep.....	102A
PVAc latex paint works on outside wood.....	102B
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Synthetic latex vies with natural in foam.....	104A
Flame retardant for polyethylene.....	104B
Growth regulator makes plants short and stocky.....	104C
Mica insulation papers are fire retardant.....	104D

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LUMMUS DESIGNS, ENGINEERS AND CONSTRUCTS HYDROGEN FEED GAS FACILITY FOR AIR PRODUCTS, INC.



World's Only Large Tonnage Plant Produces Liquid Hydrogen for Use as Missile Fuel

The world's only large tonnage liquid hydrogen facility—near West Palm Beach, Florida—has been put on-stream by Air Products, Inc. of Allentown, Pennsylvania. The Lummus-designed, engineered and constructed hydrogen production section of the plant has been producing at over-design rate and at 99+ % purity (better than design) since the test run was successfully completed 21 days after the initial operation of the

gas generators.

The hydrogen production section combines Florida crude oil, oxygen and water to generate hydrogen gas.

Liquid hydrogen product from the new facility assumes an increasingly vital role in the nation's defense system. New capability in handling, storing and firing liquid hydrogen in rocket engines substantially improves our nation's position in the race for missile and space superiority.

Lummus has completed a number of gas generation units in recent years, and also has extensive experience in design, engineering and construction of plants for ammonia synthesis.

In the past 50 years, Lummus has built over 800 plants to produce petrochemicals, chemicals and petroleum products. If your company is planning facilities of this kind, discuss your plans with Lummus.



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S-B Latex Bids to Replace All Natural for Foam

Commonly used synthetic latex at left, when concentrated to the same total solids content as new synthetic latex Pliolite 5352, is thick, hard to handle, and must be blended with natural latex for foam rubber.

With a minimum of 68% solids, the new compound at right above is easy to handle and does

not require blending with natural or other synthetic latices to make premium quality foam rubber. New and old synthetic styrene-butadiene latexes are considerably lower in price than natural rubber latex (*Chem. Eng.*, Nov. 30, 1959, p. 19).—Goodyear Tire & Rubber Co., Akron, Ohio. 104A

transfer even at very low bulk densities. —Resisto Chemical Inc., Wilmington, Del. 102C

Flame Retardant

Makes polyethylene usable in contact with electrical systems.

A commercially available flame retardant for polyethylene—trademarked Aroclor 5460—gives greater heat stability and offers fabricators better processing qualities.

Priced at 18½¢/lb. in carload quantities, Aroclor 5460—a chlorinated terphenyl—reportedly offers the combined advantages of a low cost flame-retarding agent plus the economy of faster processing by improving the melt flow of the polyethylene.

Application tests of polyethylene modified with the new compound also show greater resistance of the formulation to heat discoloration during injection and extrusion molding operations than is obtainable with other commercial flame retardants.

Additional advantages claimed include better preservation of the polymer's physical qualities (particularly tensile strength), and superior compatibility with polyethylene.

Fire retardance is expected to be of major importance for polyethylene used to replace metal near or in contact with electrical systems in refrigerators, television sets, air conditioners and other electrical appliances. —Monsanto Chemical Co., St. Louis, Mo. 104B

BRIEFS

Growth-regulating chemical which makes plants short and stocky has been discovered. The chemical is called CCC for 2-chloroethyl trimethylammonium chloride. Investigators are particularly interested in the fact that the short and stocky plant growth, obtained from CCC treatments, is opposite from the tall and elongated growth obtained by treatment with gibberellin, another type of plant growth stimulator. More complete control over plant growth might be obtained by teaming CCC up with gibberellic acid.—Michigan State University, East Lansing, Mich. 104C

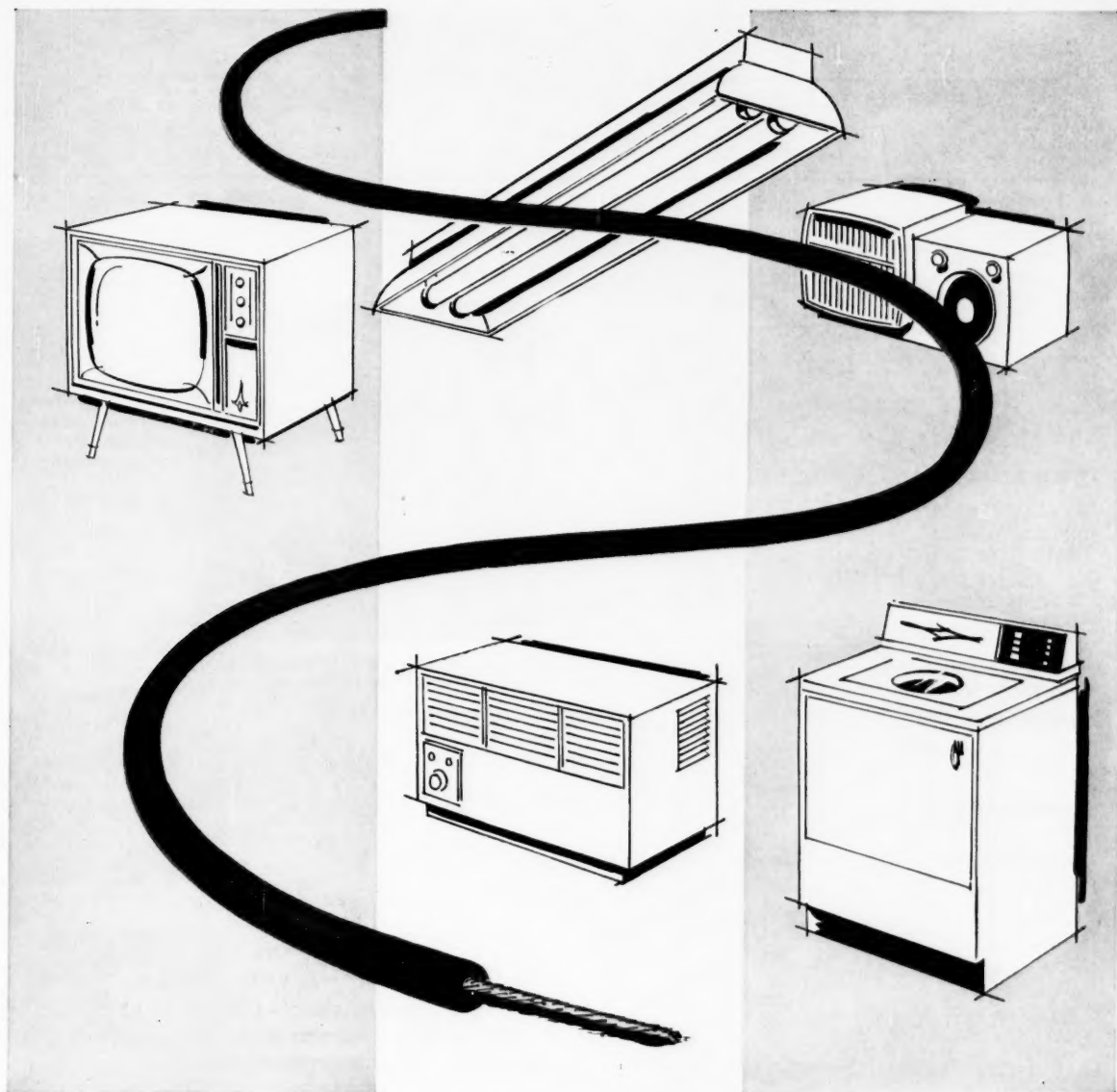
Insulation papers—inorganic, high temperature, fire resistant papers, prepared from a special type of synthetic mica—have been announced under the name Crystal M. The new papers are expected to find application as fire resistant materials, thermal insulation, electrical insulation and a variety of other uses including fire resistant document paper. —Minnesota Mining & Mfg. Co., St. Paul, Minn. 104D

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard (p 231)

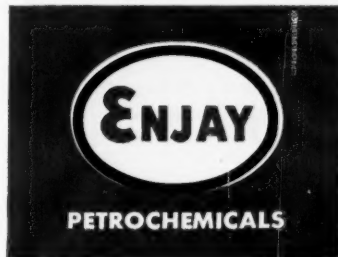


TRIDECYL ALCOHOL

To make DTDP—new low cost plasticizer for high temperature vinyl insulation

Enjay Tridecyl Alcohol is a basic ingredient of ditridecyl phthalate (DTDP), a new high performance plasticizer developed by Enjay Laboratories. DTDP is ideally suited to the manufacture of high temperature vinyl insulation for the electrical industry. The use of this plasticizer will substantially reduce costs at no sacrifice in electrical and mechanical properties. Enjay does not make ditridecyl phthalate but supplies Tridecyl Alcohol for its manufacture.

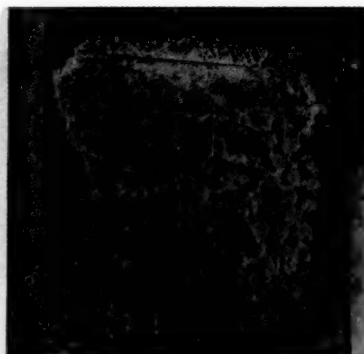
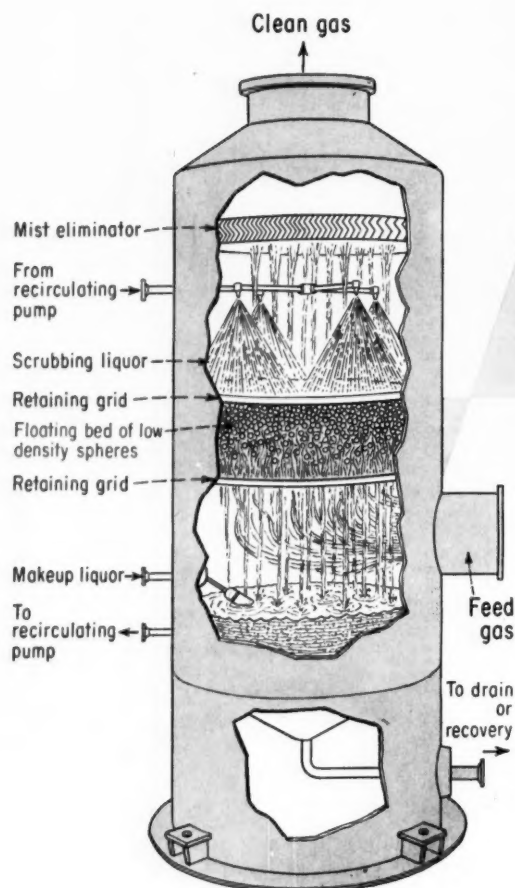
For further information about Enjay Tridecyl Alcohol, write or call our nearest office for a copy of Technical Bulletin No. 20.



EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY
ENJAY COMPANY, INC.

15 West 51st Street, New York 19, N. Y.

Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa



VIEW through window on pilot scrubber shows action in bed of spheres.

Bed of mobile spheres within this wet scrubber enables cleaning of gases containing sticky solids. Spheres also boost solids-collection and absorption efficiencies.

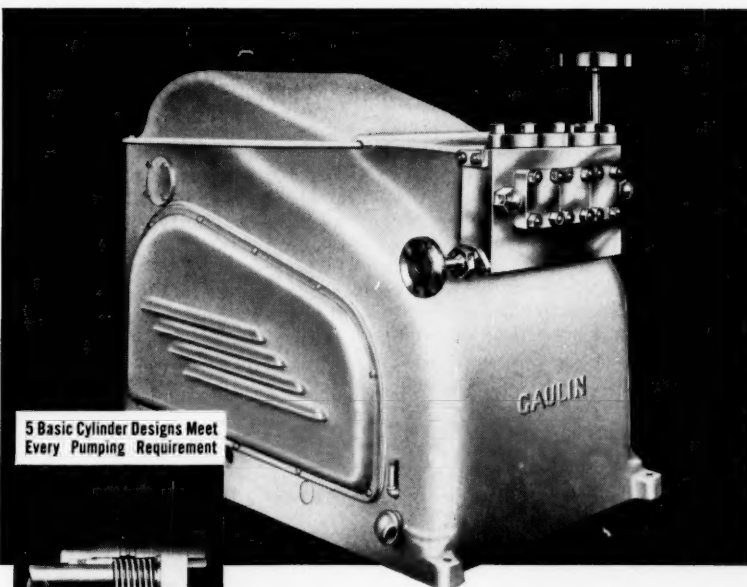
New Floating-Bed Scrubber Won't Plug

Visualize a multitude of 1½-in.-dia., low-density spheres rising, falling, floating and jostling each other within a confined area. A marathon table-tennis match gone haywire? . . . No. The key components of a new wet scrubber? . . . Yes.

Sandwiched between two retaining grids within the scrubber, the spheres form a churn-

ing, floating bed that promotes excellent contact between the scrubbing liquid and particulates or fumes being removed from the feed-gas stream. High bed mobility also prevents clogging of the unit—the constant rotation and tumbling action of the spheres scrubs away even tacky solids. Channeling is impossible.

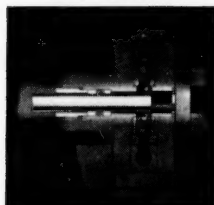
► **Proved by Application**—Now manufactured by Aerotec Industries, Inc., the scrubbers were originally developed and are currently used by the Aluminum Co. of Canada, Ltd., for absorption of hydrogen fluoride from hot process gases. Emanating from Soderberg pots used for electrolytic production of aluminum from alumina, these gas



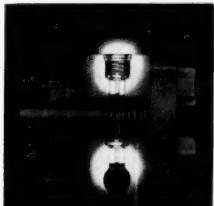
5 Basic Cylinder Designs Meet Every Pumping Requirement



Spring loaded packing



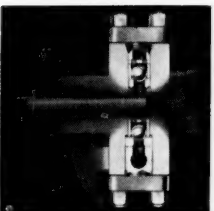
Packing adjusting screw style stuffing box



Poppet Valve, stainless steel



Ball valve, hardened inserted valve seat



Ball valve, removable seats

Gaulin Triplex Pumps Increase Your Pumping Capacity, Extend Your Pumping Pressures . . .

Reduce Operating and Maintenance Costs, Too!

Gaulin Horizontal Triplex Pumps handle large volume of all types and densities of fluids. Rugged, compact and dependable, they provide long service life at minimum maintenance costs in transfer, metering and spray drying applications.

Horizontal Design provides well area separating product from crank case.

Well Area can be gasketed for maintaining sterility . . . or for inert compatible chemicals (gases or liquid) for hazardous materials.

Gaulin Cylinder can be disassembled in minutes. Capacities from 50 to 6500 GPH . . . pressures from 500 to 12,000 psi.

Write for Bulletin P-55. At the same time ask for GTA . . . *Gaulin Technical Assistance* . . . for experienced advice and factual data on the best method to move or blend your product.



World's largest manufacturer of stainless steel reciprocating, rotary, pressure exchange pumps, dispersers, homogenizers and colloid mills.

Ask GTA...

Gaulin Technical Assistance — for data on the complete Gaulin line: Homogenizers, Colloid Mills, Submicron Disperser, Triplex High Pressure Pumps and HX Pumps. Get GTA from your nearest Manton-Gaulin Representative . . .

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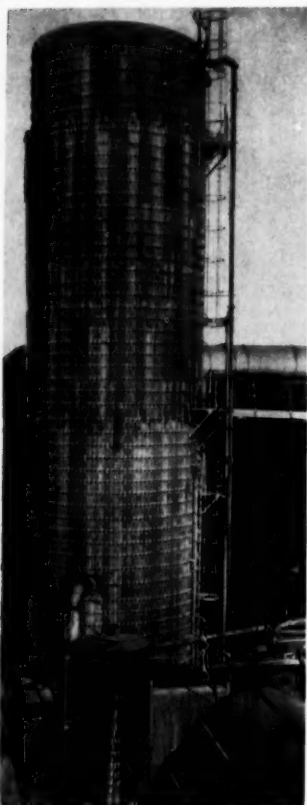
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998 Farmington Avenue



SCRUBBER for aluminum plant cleans 100,000 cfm. tar-bearing gas.

streams also contain a considerable amount of tar derived from electrode binding materials, as well as fluoride particulates.

In all, Aluminum Co. of Canada has installed six floating-bed units, each of 100,000-cfm. feed capacity. Absorption efficiencies can range upwards of 90% at a pressure drop of 4 in. H₂O, according to this firm, solids-collection efficiency varies between 95 and 100%. Outstanding feature though, says Aerotec, is that the scrubbers do not become plugged, even when handling sticky agglomerates.

► **Many Impingement Targets**—Feed gas to be cleaned travels upward through the floating bed, countercurrently to liquid flow from the distributors. Liquid, gas and particulates impinge and mingle vigorously at the spherical surfaces.

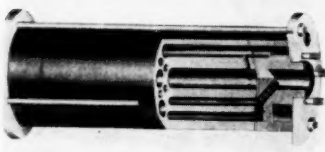
Adjustment of the flow rate of recirculating liquor controls

operation over a wide range of throughputs. Particulates and absorbed chemicals are tapped off at the unit's bottom. If required, increase in depth of the floating bed can up over-all efficiency, with only a moderate resultant rise in pressure drop.

Liquor makeup rates vary to some extent with the kinds of gases being absorbed, or with the incoming solids concentration. In the Canadian applications, about 0.25 gal. liquor will treat 1,000 cu. ft. incoming gas.

► **Materials and Sizes**—Aerotec offers their floating-bed scrubbers with body and gridwork fabricated of virtually any construction material—from wood and plastic to lead-lined steel. The spheres, which can vary considerably in size and density, are normally 1½ in. in diameter and fabricated of special plastics.

Standard capacities available range from 1,500 cfm. (2 ft. dia. by 10 ft. height) to 40,000 cfm. (10 x 32 ft.).—Aerotec Industries, Inc., Industrial Div., Greenwich, Conn. 106A



Heat Exchanger

Economical unit is immune to thermal shock.

Developed for limited-volume heating or cooling requirements, a new heat exchanger employs a single piece of impervious graphite for the heat-

transfer cylinder. Heating and cooling passages are drilled parallel to each other.

Corrosives contact only the graphite, which possesses a thermal conductivity of 1,020 Btu./(hr.) (sq.ft.) (°F./in.).

Temperatures to 340 F. are accommodated at pressures to 75 psig. hydrostatic.—Falls Industries, Inc., Solon, Ohio. 108A



Aluminum Couplings

Join sections of steam-traced piping.

Available in 10 sizes—to accommodate all sizes of aluminum steam-traced pipe—Alcast Perfect couplings feature easy assembly and leakproof construction.

Model 100 is bottom-tapped for intermediate condensate drainage. Model 100-FE is drilled and tapped for steam inlet in condensate drainage. And Model 100-B, with steam section blank, provides for connection with untraced piping or special equipment. — Alcast Fittings, Claymont, Del. 108B

Bag Filter System

Sound waves quickly clean glass filter bags.

Claimed by the manufacturer to be more efficient than electrostatic filters, the new Dracoco "Sonoclean" glass-bag filter system effectively removes dust from dry, hot industrial gases. Feature of the system are the

*Equipment Developments
Continues on page 111.*

For More Information . . .

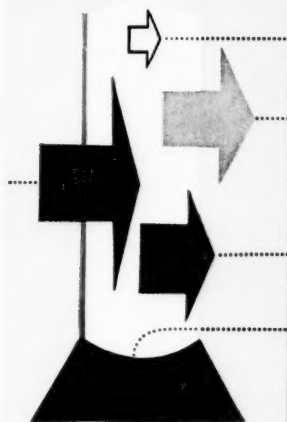
about any item in this department, circle its code number on the

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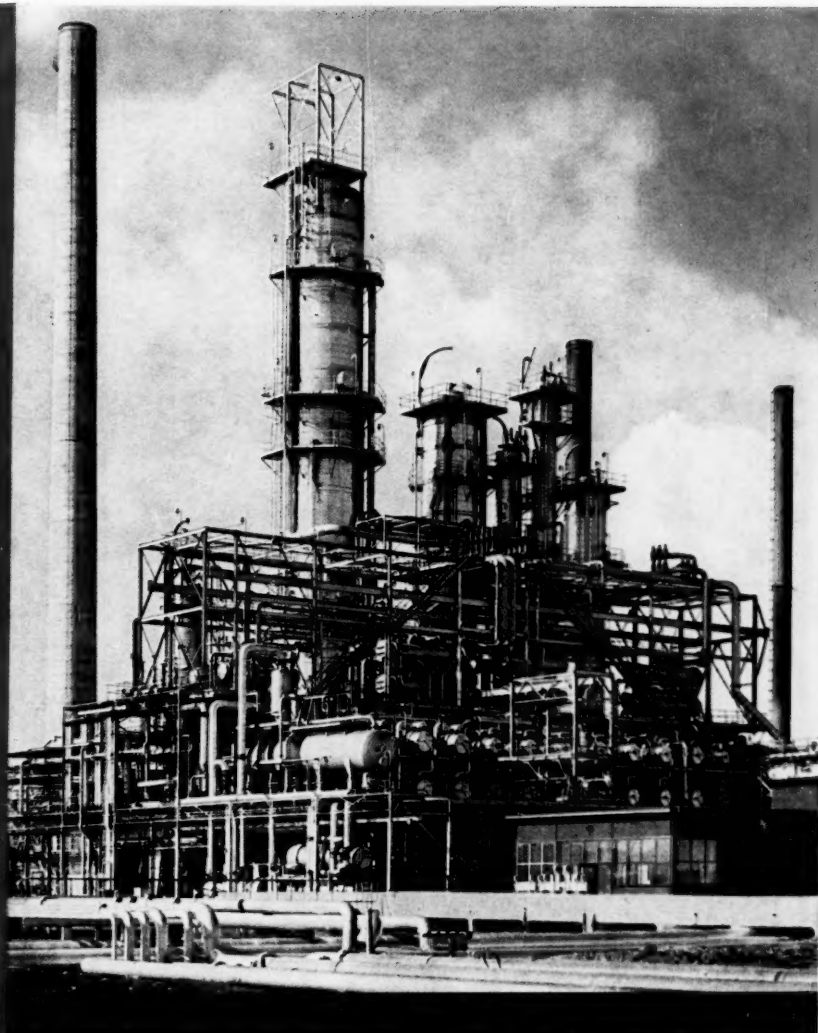
postcard (p 231)

At Shell Haven
Stone & Webster
Engineers

Provided
High
Quality
Products,
High
Efficiency



Stone & Webster
adds profits to
your project
through engineering
economies and
plant efficiency.



At Shell Haven, England, Stone & Webster Engineering Limited designed and constructed for Shell Refining Company Limited a distillation unit of advanced design to process 80,000 BPSP of Kuwait crude.

The process design represents the joint effort of Stone & Webster and Bataafse Internationale Petroleum Maatschappij and provides for flexibility in the type of feedstocks, close fractionation of products to rigorous specifications and high heat recovery reducing fuel consumption below 1.5 per cent of the charge rate.

A substantially duplicate unit, engineered by Stone & Webster, has been built at Cardon, Venezuela based on this process design.

For information concerning how Stone & Webster can be of service to you on your next engineering project, please write or call our nearest office.

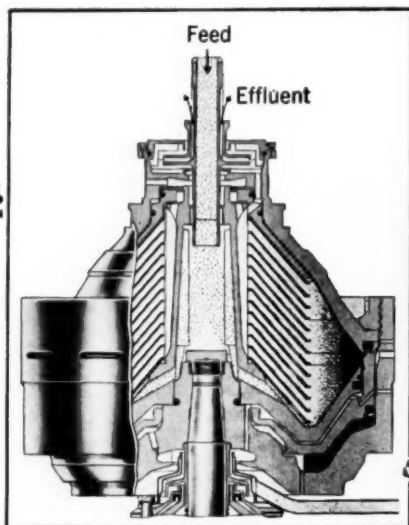
STONE & WEBSTER ENGINEERING CORPORATION

Affiliated with STONE & WEBSTER ENGINEERING LIMITED (LONDON)

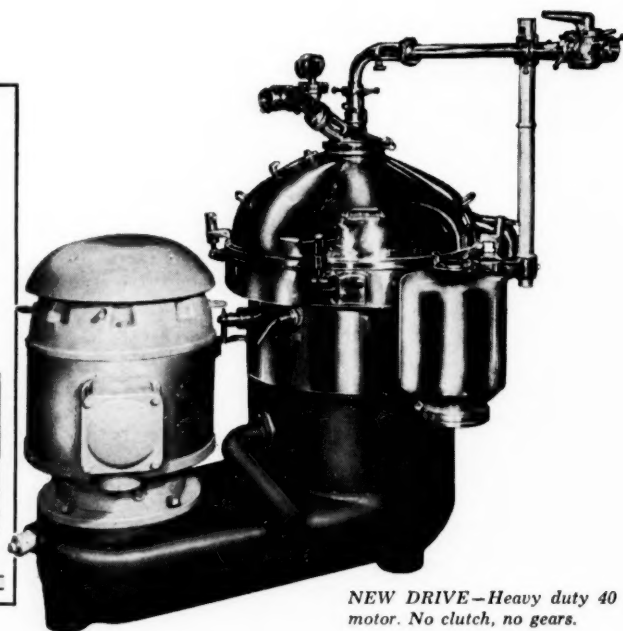
New York • Boston • Chicago • Pittsburgh • Houston • San Francisco • Los Angeles • Seattle • Toronto



NEW! WESTFALIA SAMN-15007 Automatic De-Sludger



SIMPLE—Only two more parts than in conventional disc bowl...no nozzles, valves, bolts, or springs to complicate assembly and disassembly.



NEW DRIVE—Heavy duty 40 hp motor. No clutch, no gears.

"BIG SAM" for Continuous High Capacity Clarification

...with Automatic Sludge Ejection

SAMN-5006...

"LITTLE SAM"



Same design as "BIG SAM" ...with all of the same advanced features. Performs all of the versatile operations of its "big brother". Conventional gear drive with flange-type motor.

► CONTINUOUS

"Around-the-clock" operation—up to six weeks, depending on product...up to 8000 gph capacity.

► AUTOMATIC

De-sludging cycle controlled by timing unit...choice of complete or partial de-sludging.

► SANITARY

Stainless steel construction throughout bowl and all other liquid and sludge contact parts...bowl designed for complete self-cleaning...CIP cleaning possible.

► PRESSURE DISCHARGE

Built-in pump discharges effluent free of entrained air.

Write for Bulletin on "BIG SAM"

**WESTFALIA
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CENTRICO
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75 WEST FOREST AVENUE, ENGLEWOOD, N.J. • Phone LOWELL 9-0755

sonic generators, of low audible frequency, that clean the filter bags by making them vibrate in an undulating motion, without flexing.

With recent improvements in filter design, Sonoclean extends the low operating and maintenance costs of cloth filtration methods to many difficult dust and fume problems. Two recent installations are collecting all visible dust from the waste gases of rotary cement kilns.—**General American Transportation Corp., Chicago, Ill. 108C**

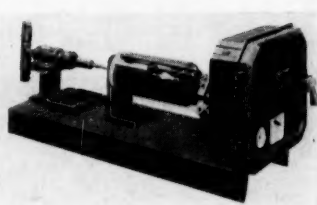


Fire Pump

Ideal for areas inaccessible to wheeled vehicles.

Goodyear's portable fire pump, a new positive-displacement unit, is both self-priming and operable in any position without loss of prime. Check valves are not required. The pump handles water with suspended abrasives at a suction lift of 28 ft. while delivering 50 gpm. at 100 psi.

A two-cycle gasoline engine is mounted with the pump on an aluminum skid. Weighing only 50 lb., the combination can be easily carried by one man. Four-cycle engines are also available for delivery on special request. **Goodyear Pumps, Inc., New York, N. Y. 111A**



Metering Pumps

Air or other gas drives explosion-proof unit.

Applications of Servo Gauge pumps include simple metering, flow ratio control, process-variable control and multiple proportioning. These new equipment items are pneumatically controlled and powered.

Use of dual check valves and the absence of bearings and linkages assure continuous and dependable accuracy—cylinder-piston and pump-plunger positioning accuracy fall within 0.002 in., repeatedly. Maximum capacities range, with various models, from 0.12 to 82.5 gph. at discharge pressures to 5,000 psi. Control discharge is linearly proportional to a 3- to 15-psig. signal. Normal operating gas pressure is 80 psig.—**Associated Control Equipment, Inc., Coraopolis, Pa. 111B**

Ball Valve

Company develops new line. Two designs available.

Hills-McCanna is making a play for a slice of the lucrative ball-valve market with introduction of their new two-model line. One model has top-entry design, the other bar-stock.

According to Hills-McCanna, the top-entry ball valve is the only ball valve that combines features of two-way flow, top entry for inline maintenance, minimum pressure drop, quick opening and a self-adjusting seat for extended life. The latter feature—self-adjusting seat design—assures maintenance of driptight shutoff.

As slight wear occurs spring pressure on ball forces it further into the wedge formed by the interchangeable and replaceable seat.

Design of the bar-stock ball valve features a prestressed seat, of either Buna N or Teflon resin, that actually seals tighter as line pressure increases. Seats on the bar-stock unit are also interchangeable and replaceable. The stem of this model cannot blow out of the valve under pressure.

Both models are offered with bronze, cast steel and stainless construction. Temperature limitation is 350 F.; pressures to 300 psi.—**Hills-McCanna Co., Chicago, Ill. 111C**



Computer

Compact machine has many big-computer features.

A small, transistorized computer, capable of performing more than 100,000 calculations per minute, requires little more space than the average desk or drafting table. Known as the IBM 1620 Data Processing System, the unit operates under direction of an internally stored program of instructions.

Magnetic-core storage capacity is 20,000 digits. Variable field length, immediate accessibility, and paper tape and electric typewriter input and output are among other features.

Availability of two advanced programming systems and a comprehensive library of mathematical and statistical routine simplifies programming. Specific programs for the petroleum industry, public utilities and optical firms are available. Rental

EQUIPMENT NEWS

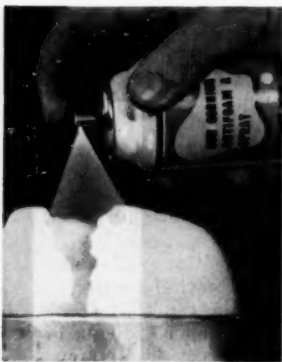
Continues on . . . Page 210

Knock-Out Drops For Foam!



Control Foam in Any Type of System with Low Cost Silicone Defoamers

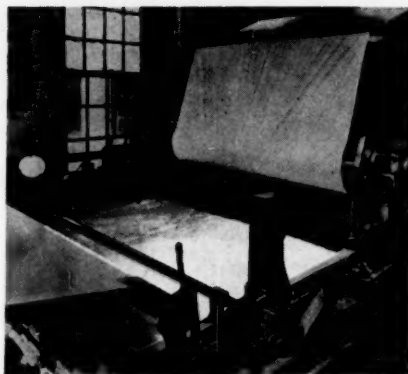
Does foam occur in your process operations? Chances are you can keep it under control at all times with a Dow Corning silicone defoamer. Job-proved in virtually every industry . . . petrochemical, textile, paper, paint, food and many others . . . Dow Corning silicone defoamers knock down the most violent and persistent foam. Eliminate processing slow-downs and boil-overs. Reduce fire hazards. Cut waste and clean-up costs.



AVAILABLE IN HANDY SPRAY CAN

And Dow Corning silicone defoamers are amazingly effective in minute quantities. For example, just 1 ounce of a Dow Corning silicone defoamer prevents foam in 31,250 pounds of dog shampoo, in 59,110 pounds of wire drawing solution, and in 62,500 pounds of paper coating solution . . . are similarly effective in defoaming adhesives, latices, caustic liquor, soap, varnish, emulsion paints and coatings, cutting oils, petrochemicals, food products . . . many, many others.

Dow Corning's continuing research study of foam and its control has brought about the availability of silicone defoamers as compounds and emulsions for different



IN PAPER SIZING

types of production systems — and in handy spray cans for split-second defoaming of smaller batch processes. Settle your foam problems once and for all time with a Dow Corning silicone defoamer. A generous trial sample is yours for the asking. Indicate your problem and system — oil, aqueous, nonaqueous, food product, or any other. Write Dept. 2624 for a rapid reply.

Your nearest Dow Corning office is the number one source for information and technical service on silicones.

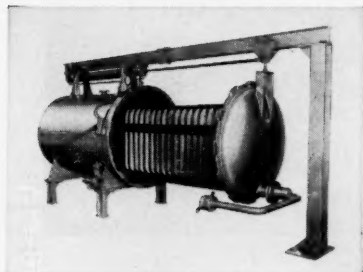


Dow Corning CORPORATION
MIDLAND, MICHIGAN

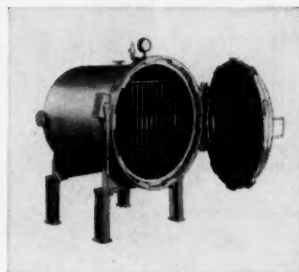
ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

PROCESS FILTERS

Process-Bowser Filters offer broad range fulfillment of process industry needs, utilizing all types of filter media. Available in special alloy tank materials and fittings. Control instrumentation for manual operation or any degree of automation.



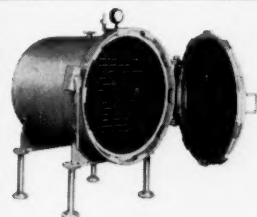
MODEL H units to 2000 sq. ft. provide capacities for large processing plants.



MODEL HB units to 400 sq. ft. meet most batch recovery needs.

MODEL HL

Available in units to 200 sq. ft. of filter area, the HL models offer advantages in cost reductions thru time and labor savings heretofore not available with horizontal leaf designs.



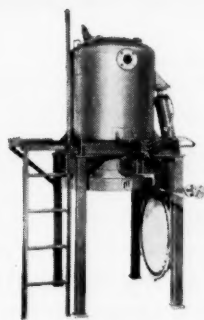
A 40 sq. ft. Model HL is capable of doing a job in less time than most filters double its size. One-man clean-out access speeds residue removal for added time savings and attendant operating economy.

MODEL HL FEATURES

- 4 to 15 minutes, one-man cleanout.
- Availability with choice of several filter media.
- Application-engineered variables to meet requirements.

EASY-ACCESS VERTICAL TYPES CONSERVE SPACE

Compact design coupled with thrifty filter leaf arrangement for continuous filtration provides units of desired capacity occupying a minimum of floor space. Convenient pipe connections make installation quick and easy.



MODEL VB units to 600 sq. ft. include bottom drop feature for heavy cake unloading.



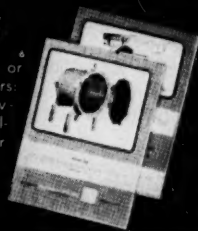
MODEL V units to 600 sq. ft. include power-lift covers and efficient cake vibrating and sluicing devices.

PROCESS-BOWSER
APPLICATION ENGINEERING
ASSURES COST-CUTTING
OPERATIONAL EFFICIENCY

Process-Bowser makes available pilot plant test filters which determine answers to new or unusual filtration problems.

MORE FACTS?

Write for one or all data folders: "Batch Recovery"; "High Solids Removal"; or "Polish Filter".



process
pf
filters

DIVISION

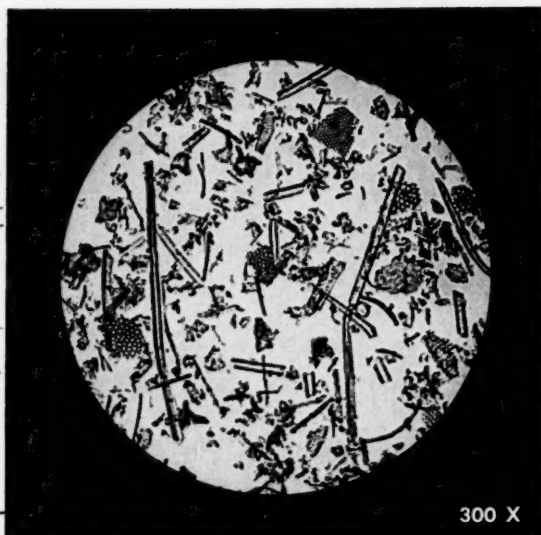
BOWSER
ESTABLISHED 1885

INC. . . FORT WAYNE, IND.

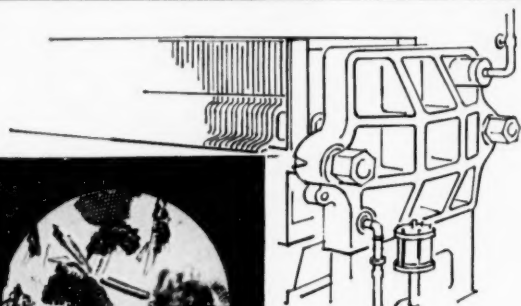
SALES ENGINEERING AND SERVICE
OFFICES IN PRINCIPAL CITIES
Liquid Control Specialists Since 1885



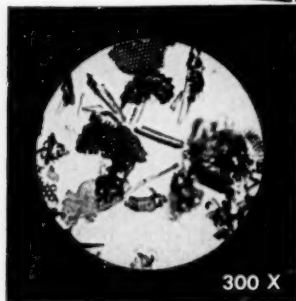
For flow rate plus clarity—Hyflo Super-Cel has the right combination of large and fine particles. Heavily used in chemical processes such as caustic soda production.



300 X



For fast flow rates—Celite 545 has a higher proportion of coarse particles. Frequently used for clarification of resins and other viscous liquids.



300 X



For maximum clarity—Filter-Cel has a relatively fine particle size distribution. Used in producing lard, salad oil, other hydrogenated oil products.



300 X

In diatomites, Johns-Manville precision processing works for you

Celite has the exact grade for every filtration need from fast flow rate to maximum clarity

Study samples of various filtration grades of Celite* diatomite with the unaided eye. Rub them between your fingers. One grade looks, feels very much like another.

Then compare these grades under the microscope. Each has its own distinctive particle size distribution. Each is precision-milled to fill the most exacting filtration requirements, ranging all the way from maximum flow rate to maximum clarity.

Celite 545, for example, with a higher proportion of large to fine particles, is used to remove large suspended impurities at maximum flow rates. *Hyflo Super-Cel®* has a balanced particle size distribution, combines good liquid clarity and moderate flow rate. But *Filter-Cel®* has a much higher ratio of small particles, is tailored for use where high clarity outweighs flow rate.

Whatever your filtration problem—Johns-Manville can furnish the "right"

grade for the job. You have a choice of 9 intermediate grades *plus* many special grades. Each comes from the largest and purest commercially available deposit. Each is processed and graded at the same plant under the same uniform conditions.

For information on specific filtration or mineral filler problems, talk to your nearby Celite engineer, or write to us. Johns-Manville, Box 14, N. Y. 16, N. Y. In Canada, Port Credit, Ont.

*Celite is Johns-Manville's registered trademark for its diatomaceous silica products

JOHNS-MANVILLE



Taylor ANNOUNCES THE TRANSCOPE* INDICATOR

Where recording function is not required, the 90K Indicator incorporates all other features of famed 90J Recorder.



The new 90K Series pneumatic Dial Indicator brings you TRANSCOPE efficiency . . . with the initial economy of process variable indication only. It can be quickly interchanged with the TRANSCOPE Recorder, thanks to plug-in connections. 90K features include:

- Color-coded target-type pointers against full 10" scale—for exceptionally easy reading.
- Powerful "Servomatic" powered pointers—assure precisely accurate pointer positioning.
- Front-of-panel control response settings give results at a glance.

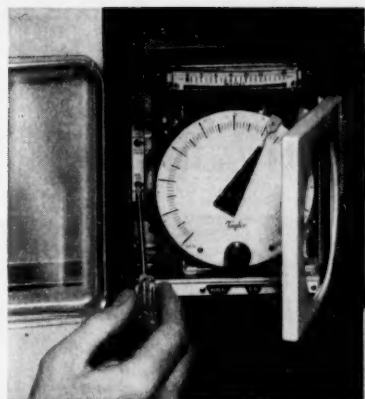
*Reg. U.S. Pat. Off.

- Same standardized components as in the 90J Recorder—minimum parts inventory necessary.

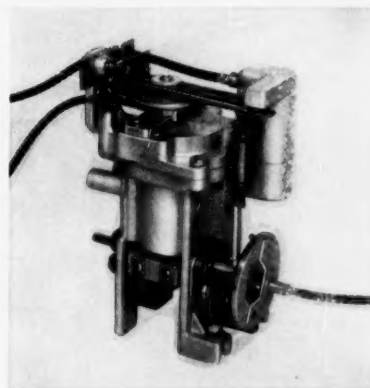
- In a control station, continuous indication of set, process and valve pressure.

Optional features include: indication of a second variable on a separate dial; Cascade switch for pneumatic set control; electric or pneumatic process alarms.

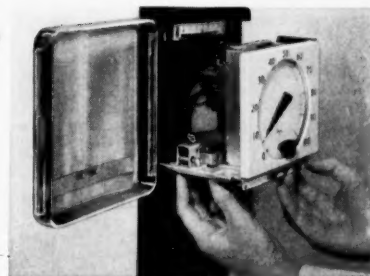
For full details, call your Taylor Field Engineer, or write for **Catalog 98347**. Taylor Instrument Companies, Rochester 1, New York, or Toronto, Ontario.



Front of Panel Adjustments. Gain, Reset and Pre-Act* response adjustments can be changed where you see the results while making the change.



Servo-operated Pointers are positioned with 150 times greater power than with conventional bellows, which also permits one or two high-low process alarms—electric or pneumatic.

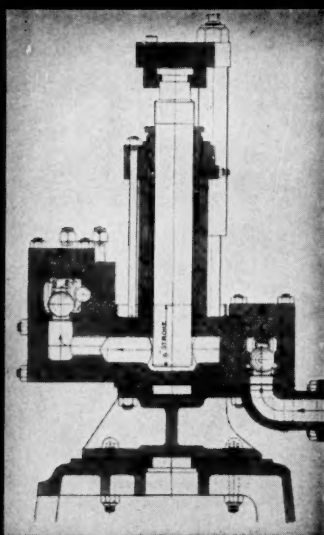
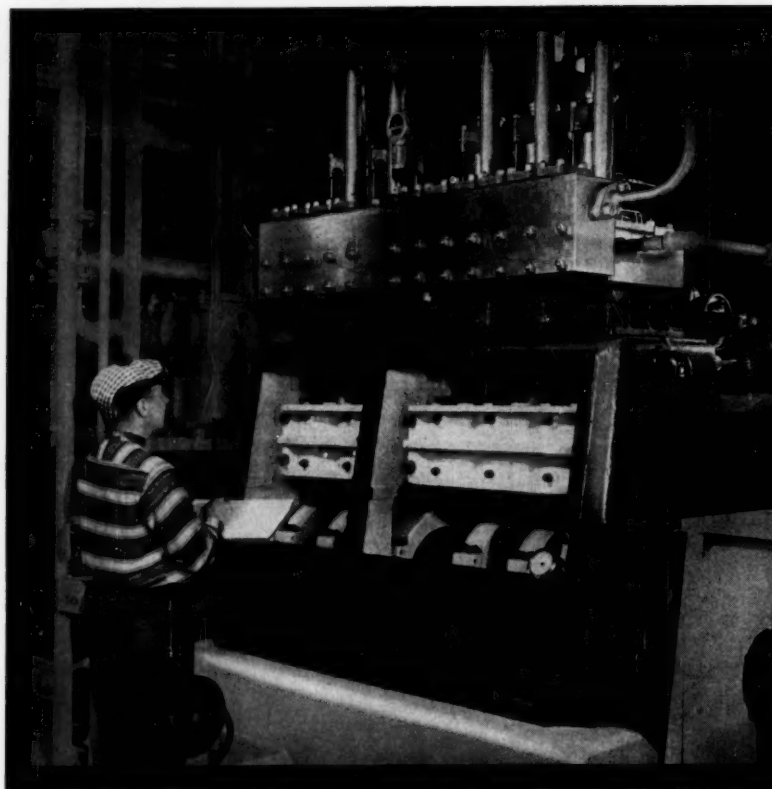


PLUG-IN Connections. The main slide, including indicator and set point transmitting mechanism, is removed by loosening one holding screw.

Taylor Instruments **MEAN ACCURACY FIRST**

AT DAVISON CHEMICAL LTD.

Aldrich pumps tame highly abrasive, corrosive slurry in high pressure spray drying operation



Special nylon ball valve construction and stainless steel fluid-end eliminates maintenance problems in handling silica gel at 1800 psi.

When Davison Chemical Ltd. built its new plant in Valleyfield, Quebec, for the production of petroleum catalysts, a major problem was to find a pump that (1) had the abrasion and corrosion resistance to stand up in a continuous high pressure process without downtime or excessive maintenance and (2) could maintain the steady pumping pressures necessary to control particle size, density and porosity of the spray dried product.

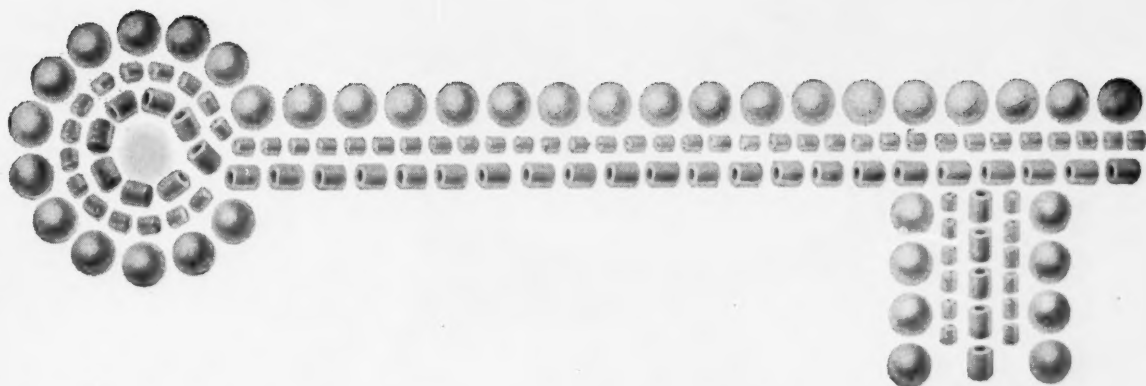
What was done: Davison Chemical engineers called on Aldrich for help and the result was the special valve design shown. After two years of continuous operation, the Aldrich pumps continue to deliver constant pressure without major overhaul. The General Manager of the plant reports: "We are quite pleased with the performance of these pumps."

How Aldrich can help you: Solving special pumping prob-

lems for the chemical industry is the most important work we do. We would welcome the opportunity to discuss your specific problems . . . no matter what the liquid or slurry, or how high the pressures. Standard Aldrich Pumps range from 25 to 2500 hp. Pressures to 30,000 psi. See our insert in Chemical Engineering Catalog for condensed data. Aldrich Pump Company, 3 Gordon Street, Allentown, Pennsylvania.

the toughest pumping problems go to





Keys to better catalysis

... *NORTON Ceramic Catalyst Carriers*

In modern chemical and petrochemical process reactions, very often the choice of proper catalyst carriers is as critical a factor as selection of the catalysts themselves. And time and again, NORTON Ceramic Catalyst Carriers have proved the *best* choice both for efficiency and economy.

It's more than just a question of a quality product. There's a personal equation involved — the Norton Man. He brings to chemical engineers the benefits of NORTON COMPANY's years of experience in the chemical and petrochemical fields as well as the end products of its advanced manufacturing and quality control methods. He *understands* the problems involved. And, backed by NORTON COMPANY's extensive research and engineering facilities, he's well qualified to help in their solution.

Whatever the feedstock or thermal

conditions involved ... whether reaction is in the gaseous or liquid phase ... whether the carrier is to be coated or impregnated with the active agent, he's ready to suggest the specific NORTON product that will do the job best. He also knows that *every* NORTON Carrier gives chemical processors the assurance of highest uniformity. From lot to lot — in any quantity — size, weight, porosity, pore diameter and purity are held to close tolerances that assure precise duplication of results.

Take advantage of the service the Norton Man represents. Let him help you to meet catalyst carrier specifications exactly. It's the simple practical way to insure maximum catalyst activity and life ... to keep catalyst costs low ... to get optimum yield from your process. Write NORTON COMPANY, Refractories Division, 512 New Bond Street, Worcester 6, Mass.

WIDE RANGE OF TYPES AS FOLLOWS

Shapes	Materials
Spheres	Alumina
Rings	Silicon Carbide
Pellets	Fused Magnesia
Granules	Zirconia
Powders	Silica, Zircon
	Magnesia — alumina
	Spinel, etc.

Porosity — from 10% to 50%

Surface Area — from less than 1 to 70 m²/gram*

*BET Method

NORTON

REFRACTERIES

Engineered... *R*... Prescribed

Making better products ... to make your products better

NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — BENR-MANNING DIVISION Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

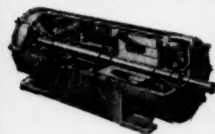
what do you need
in an adjustable
speed drive?

Better Regulation!

Less Maintenance!

Compactness!

7½ hp Ajusto-Spede Drive



Common motor-drive housing for units up to 7½ hp saves space — can be foot- or flange-mounted. Larger sizes up to 100 hp with individual motor and drive housings mounted integrally.

The Louis Allis AJUSTO-SPEDE® drive is more compact, precise, and trouble-free



Here's an adjustable speed drive that allows *truly precise* machine operation. Speed regulation is automatic and stepless — results in faster, more efficient production at lower cost, with less waste, and minimum wear on equipment.

These and other benefits are yours when you use the improved Louis Allis Ajusto-Spede drive. For example, it can be set before or during operation to deliver any desired speed within its range. Its *exclusive* tachometer feedback circuit monitors the output speed and *automatically corrects speed and holds it* regardless of load changes.

This improved drive requires minimum maintenance. Its stationary field has no brushes, commutators, or slip rings to cause trouble. The source of power is an equally trouble-free standard a-c squirrel cage motor.

®Ajusto-Spede is a registered trademark of the Eaton Mfg. Co.

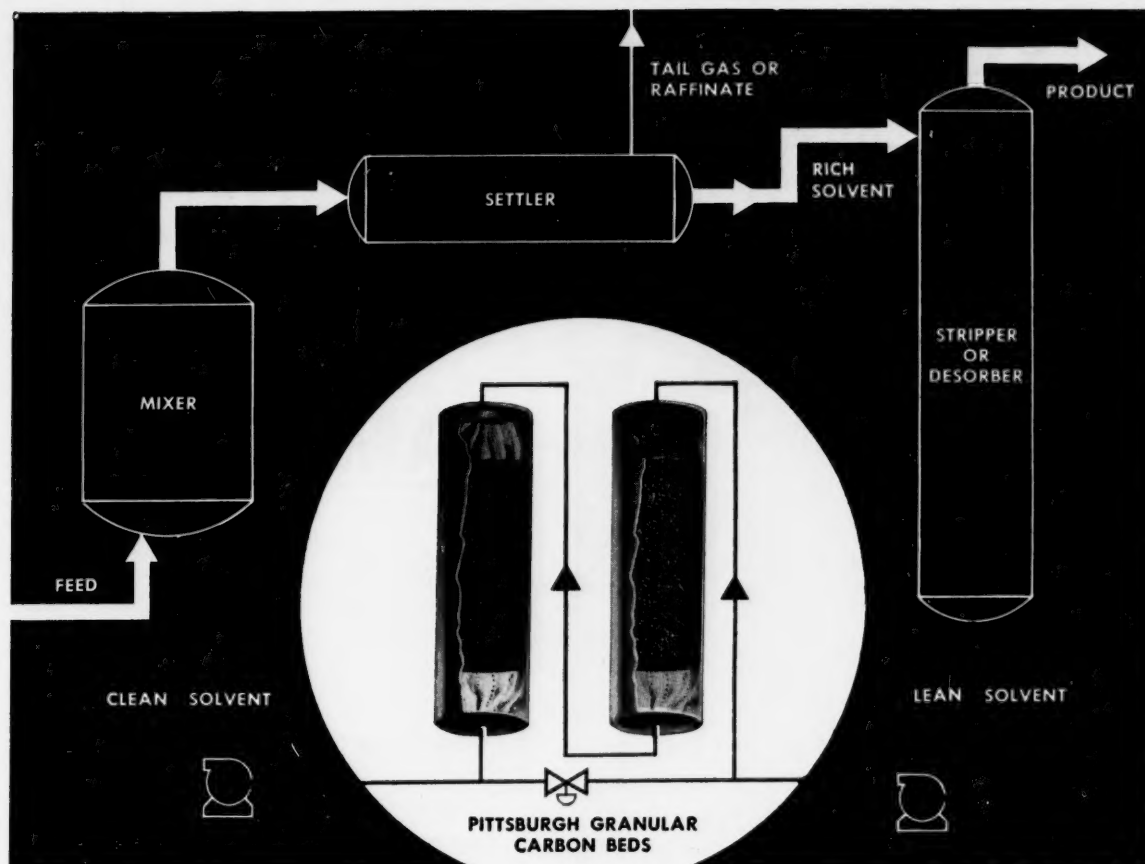
The cast-iron housing keeps out dirt, chips, and moisture — resists corrosion.

The compact Ajusto-Spede also saves space. Integrally-mounted motor and drive simplify handling — can be easily adapted for installation on new or existing machines. Controls can be mounted at the machine or any other convenient position.

The Louis Allis Ajusto-Spede drive is the practical solution to almost every application that requires dependable, easily controlled adjustable speed. It is the answer to precise operating speeds for machine tools, process machinery, test equipment, windups, conveyors, printing presses, and other equipment. Contact your Louis Allis District Office for information and application help. Or write for bulletins 2750 and 2800 — The Louis Allis Co., 447 E. Stewart St. Milwaukee 1, Wis.

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES



Improve Solvent Extraction and Absorption Efficiency with PITTSBURGH ACTIVATED CARBON

Does your process utilize acids, alkalis, amines, glycols or other costly solvents which must be re-circulated for repeated use? If so, you can maintain higher solvent selectivity and efficiency, and eliminate sewerage a side stream by circulating the solvent through a bed of PITTSBURGH Granular Activated Carbon.

In butadiene manufacture, for example, PITTSBURGH Activated Carbon is used to reduce the accumulation of organic contaminants in a recirculating stream of cuprous ammonium acetate.

In the same manner, recirculating streams of amines used in gas purification are kept free of contamination with PITTSBURGH Granular Carbon. Often, it is only necessary to carbon treat a portion of the solvent stream to remove accumulated organic contaminants.

Use of PITTSBURGH Activated Carbon in this manner results in:

1. Increased selectivity and capacity of the solvent.
2. Reduced solvent make-up or cost of reclaiming.
3. Elimination of foaming in evaporators or distillation towers.
4. Reduction of corrosion and maintenance.
5. Improvement of quality of end product.

Our technical representatives will be glad to evaluate and advise whether or not such improvements are possible in your system. • Write today for more information . . . or a visit from a PITTSBURGH technical representative.

* * *

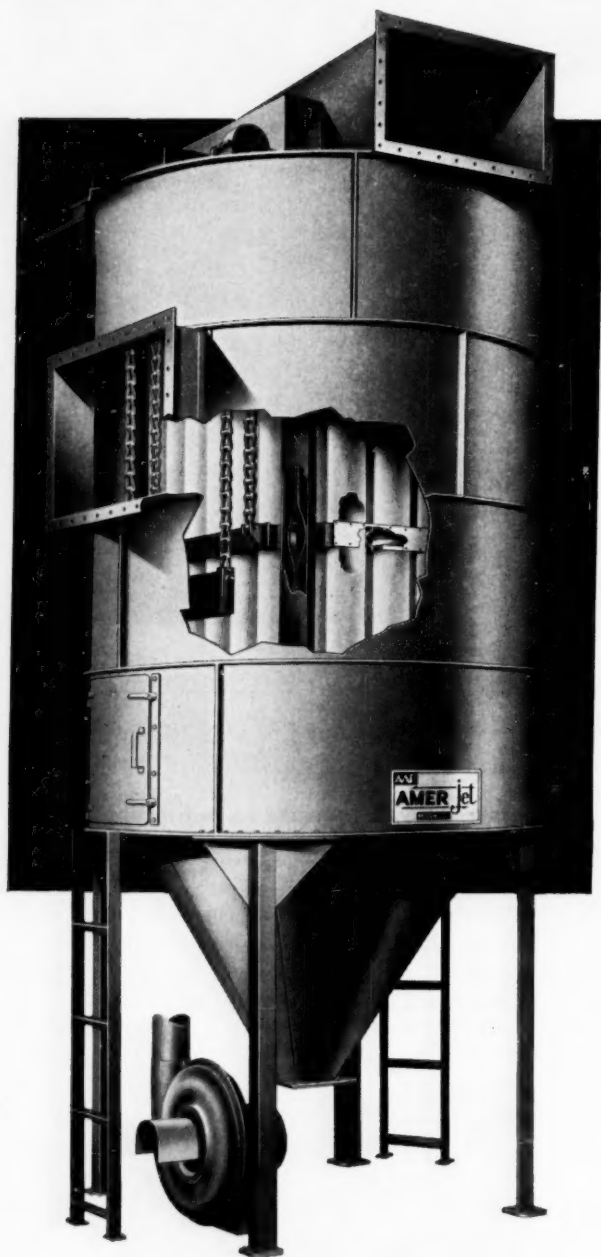
Send for Booklet

Describes types and various applications of PITTSBURGH Activated Carbons in both liquid and vapor phase adsorption. For your free copy, write to Dept. V.



COAL CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON • FERROMANGANESE

NOW—a constant-volume, compact fabric dust collector!



AAF's new Model B **AMERjet**

This new AAF unit answers the need for a compact dust collector capable of handling heavy dust loadings of materials of varying nature—with a constant pressure drop that assures accurate control from most dust sources. Check these important features of the new AMERjet:

- 1. FEWER FILTER BAGS**—A 10,000-cfm AMERjet contains only twenty-six 21-ft. bags compared with 200 for a conventional unit of the same height.
- 2. GREATLY REDUCED SPACE REQUIREMENT**—Requires just half the area utilized by tube-type or flat-envelope cleaning units!
- 3. SUPER RUGGED DRIVE**—Allows bag cleaning mechanism to operate even under extreme dust loadings.
- 4. MAINTENANCE REDUCED**—All housing and hopper panels are of galvanized construction, need no painting. Only two points for semi-annual lubrication. Complete set of bags replaced in one morning.
- 5. MODULAR DESIGN**—AMERjets can be interconnected for large installations. This allows servicing of any unit without shutting down system.
- 6. JOBSITE CONSTRUCTION REDUCED**—No special shipping problems. All sizes fit standard highway trailers.

For complete information on the new Model B AMERjet, write for Bulletin 279C. Address: Mr. Robert Moore, American Air Filter Company, Inc., 326 Central Avenue, Louisville, Kentucky.



American Air Filter
BETTER AIR IS OUR BUSINESS

Don't Price Yourself Out of the PLUS Features You Get with SQUARE D CONTROL CENTERS

Industrial construction

All outer surfaces and structural parts are 12 gauge steel. Corner channels, cross members and doors are formed on special dies for maximum rigidity. Rust-resisting finish—phosphatized plus baked enamel.

Saves space

Unit heights in 3-inch increments—an exclusive Square D advantage which permits use of units with minimum heights, eliminates the wasted space typical of modular systems.

Built-in safety

Units are metal-enclosed to confine damage should a fault occur. Unit side plates are permanently attached—can't be accidentally discarded. Switch-type units have visible blade disconnects for added safety.

Extra control flexibility

A variety of removable panels accommodates up to four oil-tight push buttons and pilot lights.

Tubular vertical buses

Another Square D "exclusive"—inherently stronger—greater cooling surface. Extra-wide spacing between phases gives added "break-down" protection. Plug-in stabs are silver-plated copper backed by steel springs—give high pressure low resistance contact at all times.

Liberal wiring space

Wiring channels are large and accessible. No wire fishing through narrow passageways—wires can be laid in position—less costly installation.

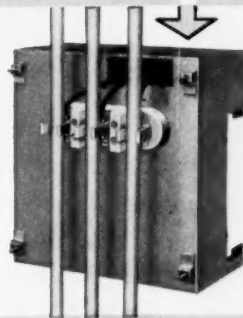
GET THE COMPLETE STORY

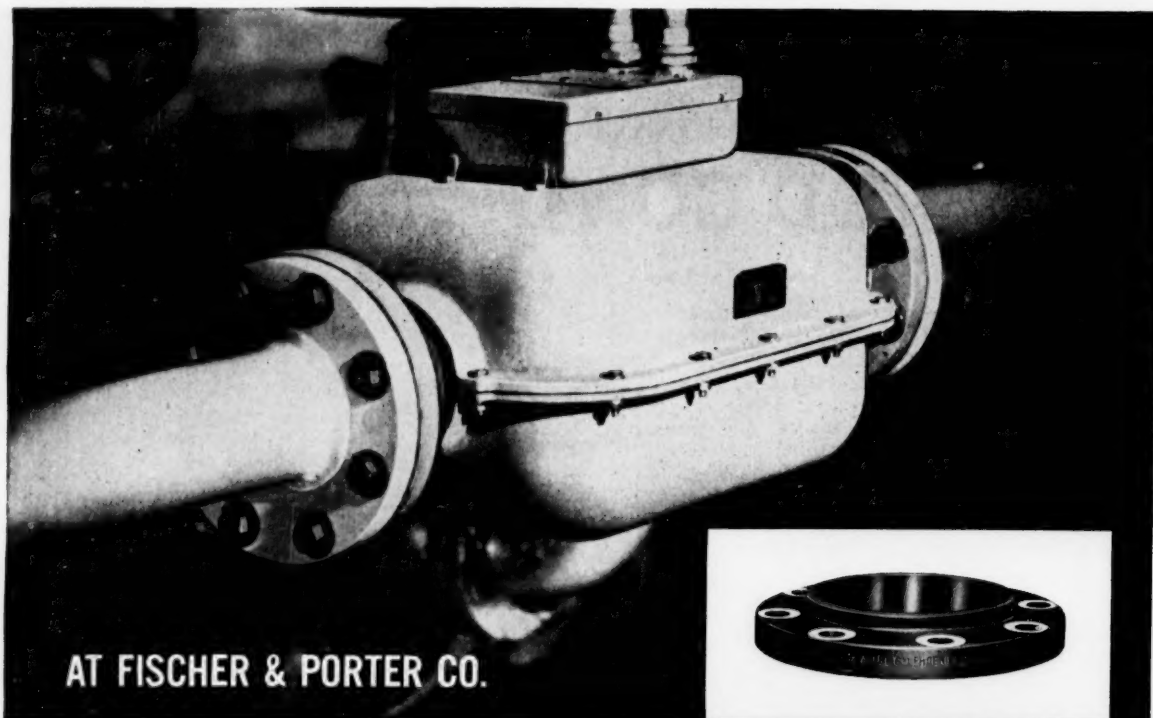
BULLETIN SM-244 gives detailed information on all of the "plus" advantages you get when you specify Square D motor control centers. Send for a copy. Square D Company, 4041 North Richards St., Milwaukee 12, Wis.



SQUARE D COMPANY

wherever electricity is distributed and controlled





AT FISCHER & PORTER CO.

... A Partnership in Quality MAKES POSSIBLE A NEW FLEXIBILITY IN FLOWMETERING

Fischer & Porter, noted for their quality metering devices, manufacture Magnetic Flowmeters used by all industries where accurate flow measurement is required. Accuracy can be held to plus or minus 1% even under the most difficult operating conditions. At their plant in Hatboro, Penna. their design, engineering, production and purchasing departments all demand quality and service. That's why Phoenix pipe flanges have been specified and relied upon for years.

Specify Phoenix too. You can't buy a better flange.



YOU GET ALL THIS IN PHOENIX FLANGES:

- Forged Steel. Shot Blasted.
- Full A.S.A. Specifications—Carbon Steel and Alloy.
- Spot-faced Bolting Surfaces, Extra Fine Facings, Accurate Threading and Protective Coating
- Serrated Gasket Surface Finish Is Standard On ALL Flanges With Raised Facings
- Precisely Machined Welding Bevel
- Special Facings, Bores, Drilling, Threading and Special Machining

Leading Manufacturers of Pipe and Tank Flanges and Commercial Forgings



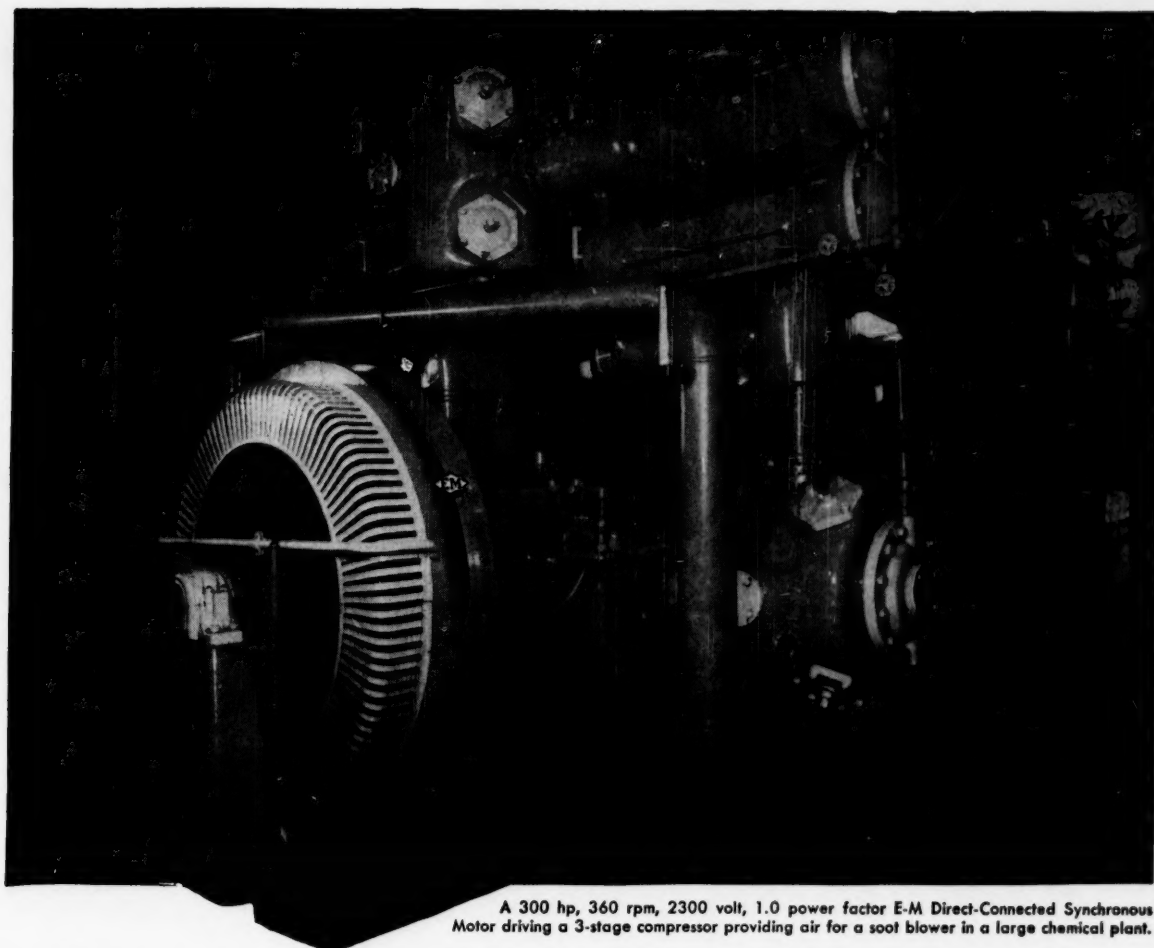
FLANGE AND FORGING DIVISION

PHOENIX MANUFACTURING COMPANY

DIVISION—UNION TANK CAR COMPANY

CATASAUQUA, PA. • JOLIET, ILL. • FOUNDED 1882

PHOENIX DIVISIONS: FLANGE AND FORGING DIVISION, STEEL MILL DIVISION, HORSESHOE PRODUCTS DIVISION, FABRICATING REBAR DIVISION



A 300 hp, 360 rpm, 2300 volt, 1.0 power factor E-M Direct-Connected Synchronous Motor driving a 3-stage compressor providing air for a soot blower in a large chemical plant.

What every new compressor should have

● Nicest thing you can do for a new large compressor is to couple an engine-type synchronous motor to it. There's no better way to assure a most economical, reliable and trouble-free drive. Look at the advantages:

1. HIGH EFFICIENCY conversion of electric power to mechanical power by synchronous motors . . . resulting in minimum electric power cost operation of the compressor.

2. POWER FACTOR CORRECTION by unity or 0.8 leading power factor synchronous motors . . . supplying leading reactive kva to improve plant power factor and further reduce power costs, save money on your power bills.

3. DIRECT-CONNECTED synchronous motors save valuable floor space and require minimum maintenance.

4. SIMPLE STARTING at full voltage is suitable for most direct-connected synchronous motor compressor applications. Or you can use E-M-invented part-winding starting where starting limitations are severe. E-M starting arrangements are low in first cost and maintenance cost.

And there's nothing nicer for your compressor than an *E-M* Direct-Connected Synchronous Motor. E-M, pioneers in the development of synchronous motors and control, have over 40 years' experience in the design of synchronous motors incorporating desirable characteristics and features such as those above.

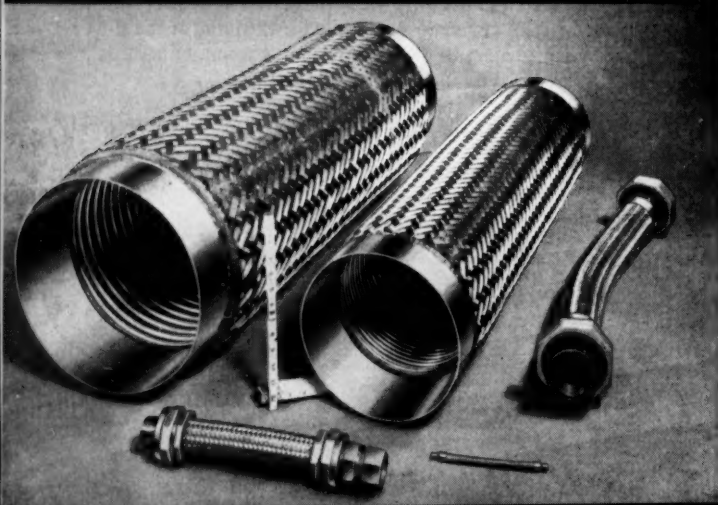
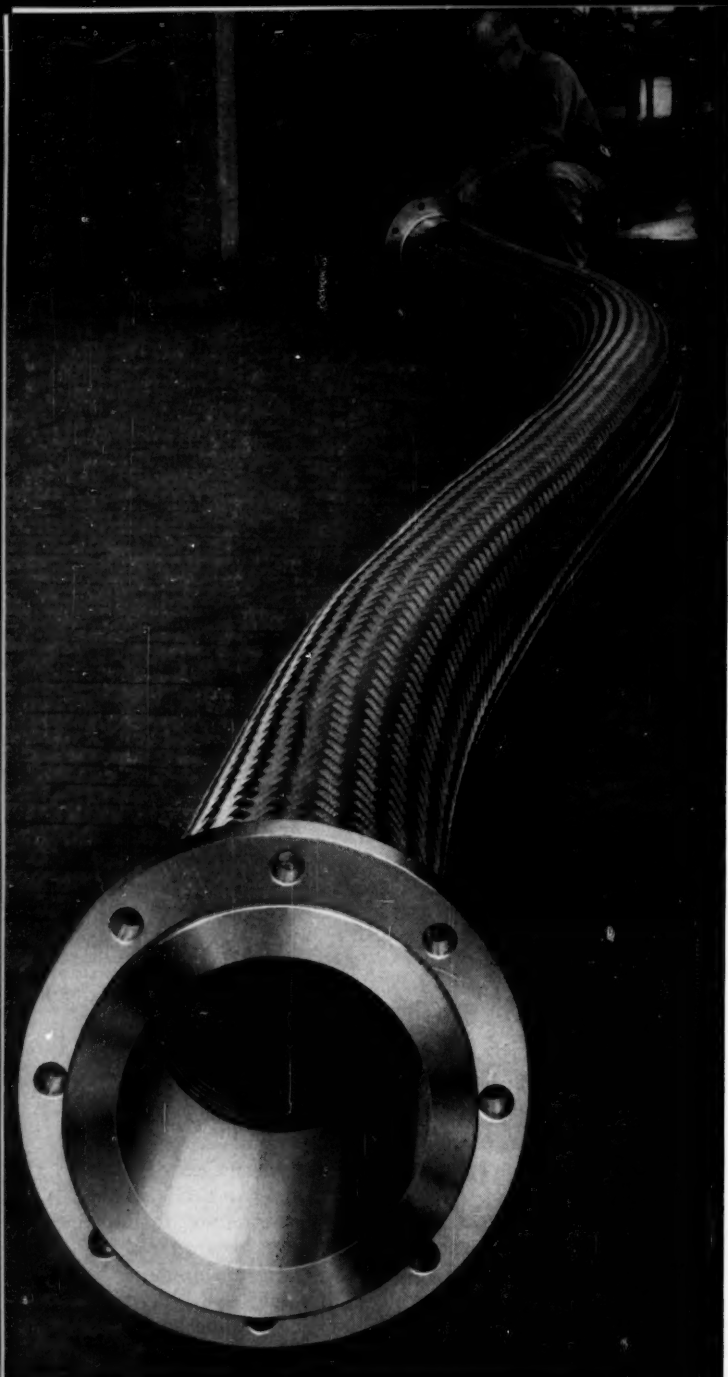
Let the E-M specialist engineer team design a smooth-running, modern drive unit to meet the requirements of your new compressor application. For complete information on E-M Synchronous Motors and their application in your plant, consult your nearest E-M sales engineer. And write for the issue of the E-M Synchronizer titled "The ABC of Synchronous Motors".

ELECTRIC MACHINERY MFG. CO.
MINNEAPOLIS 13, MINNESOTA

1200-TPA-2136



**Specialists in
BIG MOTOR ENGINEERING**



BIG OR SMALL

FLEXIBLE TUBING ANSWERS TO TOUGH PROBLEMS

The flexible metal tubing assemblies on this page give an indication of the scope of facilities at Anaconda Metal Hose for designing and manufacturing tubing answers to tough problems.

The big 16½-foot, 8-inch diameter tube in stainless steel at the left was built for handling liquid oxygen in missile ground handling equipment. In the photo below, left rear, are two stainless steel connector assemblies—14-inch and 10-inch I.D.—also used in handling liquid oxygen.

From such assemblies down to the tiny ⅛-inch I.D. Vibration Eliminator shown in the foreground at the bottom of the page, the variety of flexible hose assemblies—in size, material, and design—is almost infinite.

FREE TECHNICAL SERVICE. Anaconda Metal Hose specialists are constantly working with design engineers on special flexible connectors and hose to meet new problems. Having broad experience working in stainless steel, other steel alloys, Monel, copper alloys, aluminum, and Teflon,* they can save you considerable time and money in designing the flexible connector best suited for your needs.

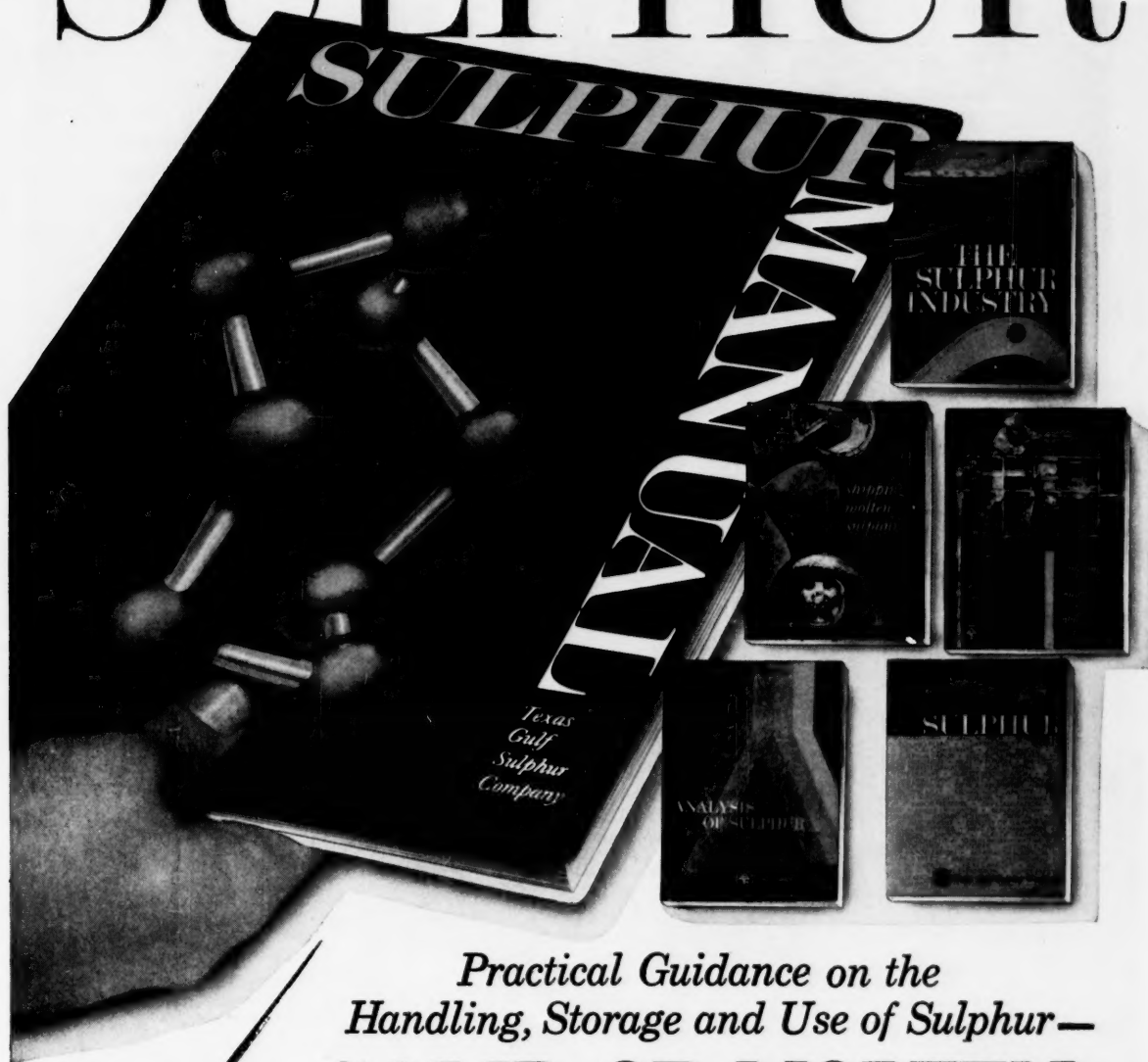
Our specialists are available to you through Anaconda Metal Hose representatives in leading cities — see listing "Metal Hose" in the Yellow Pages. Or write: Anaconda Metal Hose Division, The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. *Registered trademark for Du Pont fluorocarbon resins.

59130

ANACONDA®

METAL HOSE

SULPHUR



Practical Guidance on the Handling, Storage and Use of Sulphur— SOLID OR MOLTEN

- I — The Sulphur Industry**
II — Shipping Molten Sulphur
III — Handling and Storage of Molten Sulphur
IV — Analysis of Sulphur
Appendix — Physico-Chemical Properties of Sulphur

Old hands, accustomed for years to handling Solid Sulphur, will need little advice, if any...unless Molten Sulphur is to be in the picture for the first time. In this case, our experience with and knowledge of Molten Sulphur may be helpful.

But new plants entering the Sulphur-consuming picture for the first time should find our service of considerable help regardless of the kind of Sulphur used. One facet of this service consists of a well-documented

and well-illustrated 5 section Manual covering all phases of the handling, storage and use of Sulphur, both solid and molten, plus useful information on sampling, analyzing, and broad properties of Sulphur.

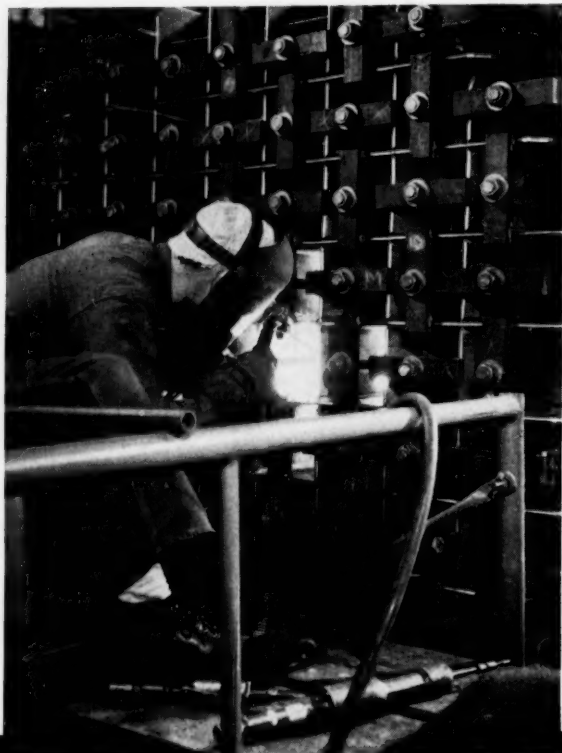
As a preliminary to any service in person you may require—and which we shall be glad to provide—would you like to have a copy of this Manual? Please write us on your company's letterhead and address your request to our Sales Department.



TEXAS GULF SULPHUR COMPANY

75 East 45th St., New York 17, N. Y. / 811 Rusk Ave., Houston 2, Texas
 Sulphur Producing Units: Newgulf, Texas • Spindletop, Texas • Moss Bluff, Texas
 • Fannett, Texas • Worland, Wyoming • Okotoks, Alberta, Canada

Reactor core supports of steel, signal bridges of aluminum ... evidence of B-L-H scope and skill in fabrication



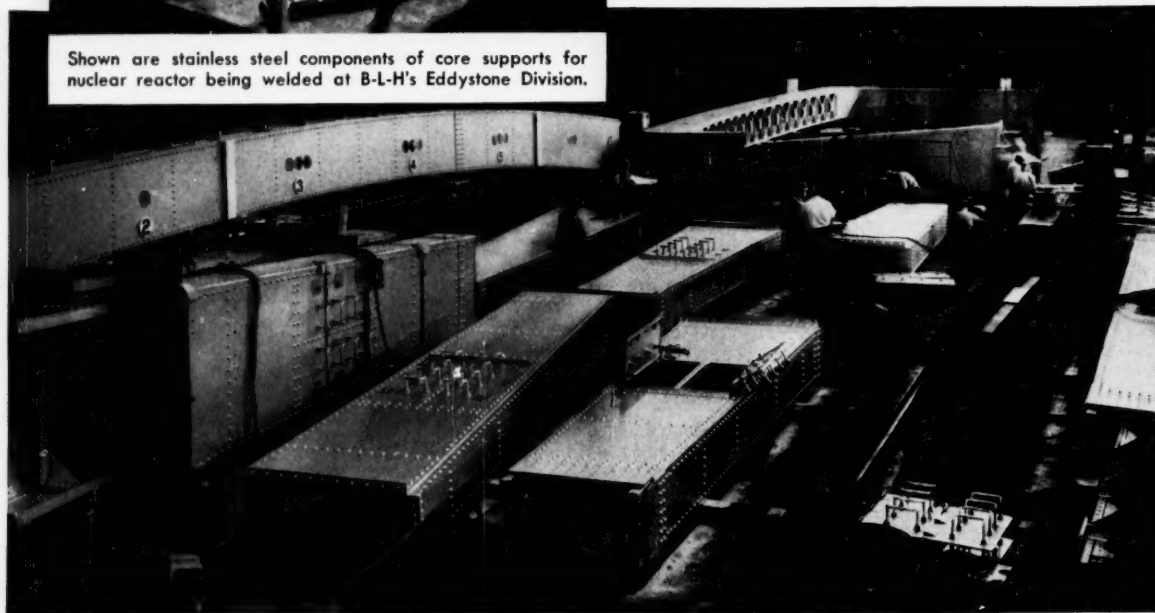
Shown are stainless steel components of core supports for nuclear reactor being welded at B-L-H's Eddystone Division.

Traffic signal bridges or nuclear reactor core supports, 100-ton pressure vessels or a hub and shaft assembly for a wind tunnel—no matter how big or unusual or complex the fabricating job, whether ferrous or nonferrous metals, B-L-H's Eddystone Division can handle it—economically, swiftly, expertly.

The signal bridges (see illustration) were constructed of structural aluminum sections, plates and bars in conformance with the strictest specifications. There are 15 of these structures, and they are 84 feet long. In Eddystone's huge shop—13 bays, each 900 ft. long—handling these giants presented no problem.

The nuclear reactor core supports, fabricated of stainless steel, called for rolling, welding, stress-relieving, and extremely accurate machining. In spite of the close tolerances required, expert planning and accurate manufacturing permitted final assembly of the core and core components with ease and a minimum of selective preassembly.

Write us for a free copy of our illustrated Weldment Bulletin 7001. It will give you an excellent idea of the broad scope of our work.



Components of traffic signal bridges for Delaware River Turnpike Bridge in vast fabricating shop at Eddystone.

BALDWIN • LIMA • HAMILTON
Eddystone Division

Philadelphia 42, Pa.

Hydraulic turbines • Weldments • Dump cars • Nonferrous castings • Diesel engines • Special machinery • Bending rolls • Ship propellers





SARAN LINED PIPE



5 miles of pipe, 12 years of service

Saran Lined Pipe keeps process acids flowing!

When five miles of process piping must carry an unfailing flow of highly corrosive acids, thorium salt solutions and slurries . . . when frequent flow changes require quick, on-the-spot pipeline modifications . . . that's when the extreme corrosion resistance and easy workability of Saran Lined Pipe make this process pipeline a process lifeline.

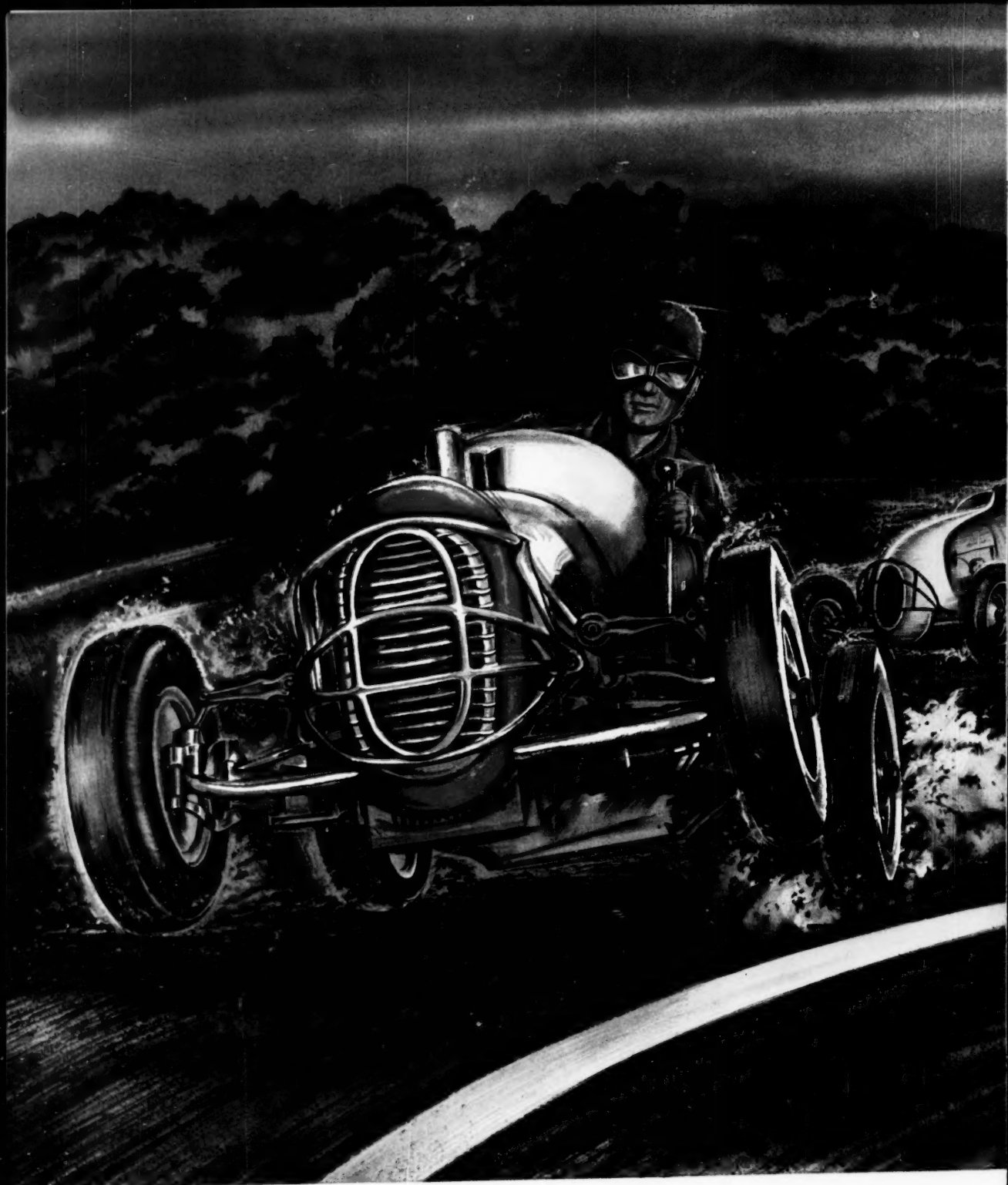
Above is one section of the approximately five miles of Saran Lined Pipe which carries process chemicals in thorium recovery operations at the American Potash & Chemical Corporation's Lindsay Chemical Division plant, West Chicago, Illinois. In this process, Saran Lined Pipe is required to carry highly corrosive materials: sulphuric acid slurries for ore leaching; reacted thorium sulphate solutions and waste slurries; concentrated hydrochloric acid, hydrofluoric acid slurries. The pipe network has been in constant use since

1947, and *there's never been a major process shutdown because of pipeline failure!*

Equally as important to Lindsay as corrosion resistance are the workability and strength of Saran Lined Pipe. The nature of the process requires frequent flow changes, meaning frequent changes in piping. Necessary pipeline modifications are done quickly and easily by plant personnel, cutting process downtime to a matter of hours. And high physical strength of the pipe minimizes the need for extensive pipe supports!

Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200°F. They can be cut, fitted and modified easily in the field without special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Ave., Ferndale, Michigan, Dept. 2283AK12-14.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN



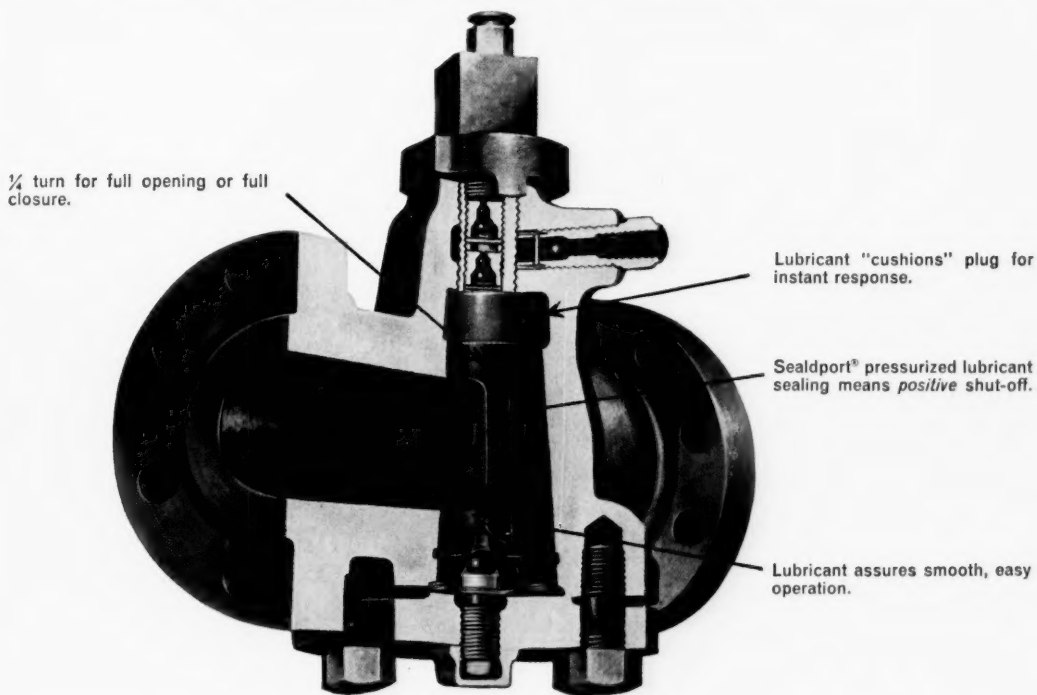
ROCKWELL-Nordstrom VALVES

Where control is vital

It isn't just speed and power that wins races . . . it's *control* that makes consistent winners.

It's the same with valves. Valves that are awkward or slow to operate may "lose the race" against impending disaster or costly flow control errors. That's why, wherever flow control must be instantly responsive, you'll see Rockwell-Nordstrom lubricated plug valves. Their *quarter-turn* lubricated closure means perfect control *every time*. The drawing below shows why these valves are so often demanded for the flow control jobs where errors can't be tolerated . . . and why they make flow control fool-proof on every service.

PERFECT, FOOLPROOF VALVE OPERATION



Rockwell-Nordstrom is the original and world's most complete line of lubricated plug valves with sizes from 1/4" to 36" and pressures to 15,000 lb. Available at leading oil field and industrial supply houses everywhere. For details, see your supplier or write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. If you live outside the U. S. A., write: Rockwell International Division, Pittsburgh 8, Pa.

©Reg. T.M. Rockwell Manufacturing Company

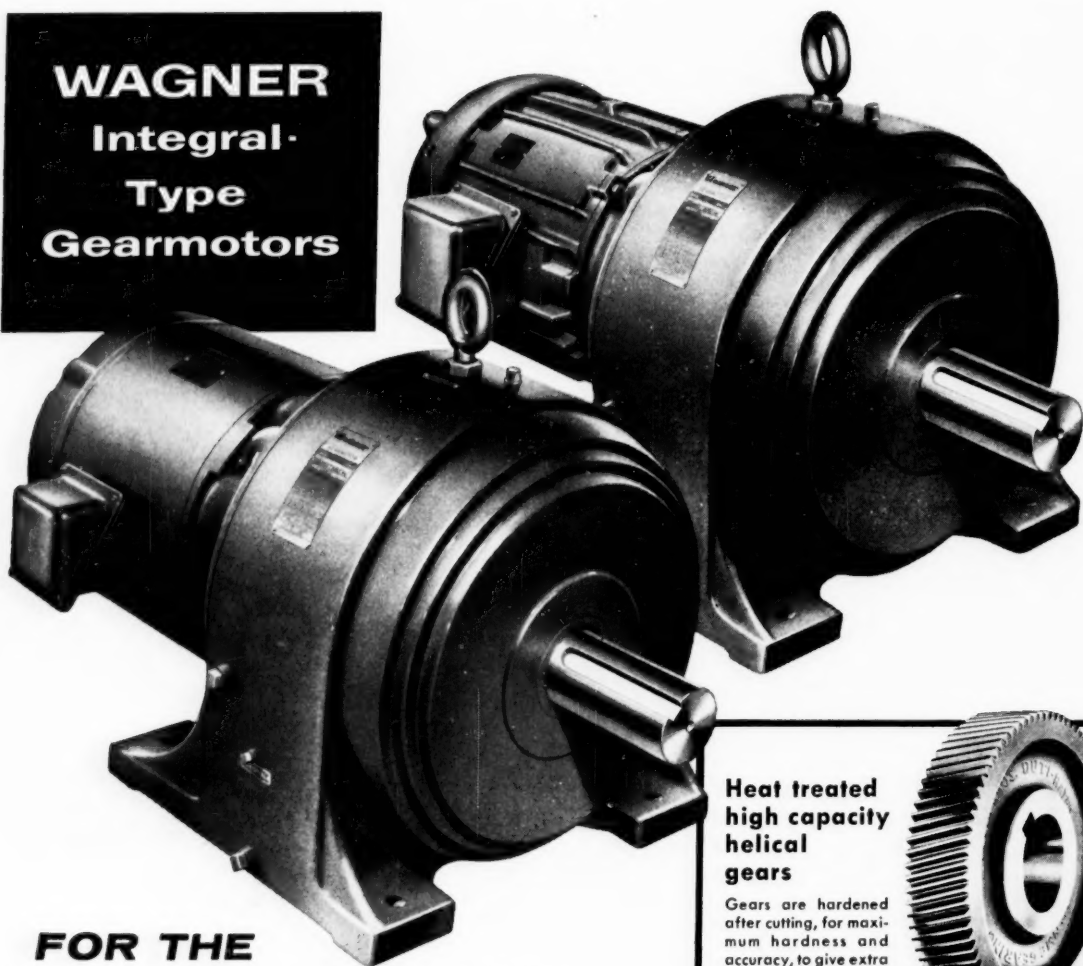
ROCKWELL-Nordstrom VALVES

another fine product by

ROCKWELL



WAGNER Integral- Type Gearmotors



FOR THE POWER YOU WANT AT THE SPEED YOU NEED

Wherever you need "slower than motor speeds" you can get positive speed reduction with plenty of power by using Wagner Gearmotors.

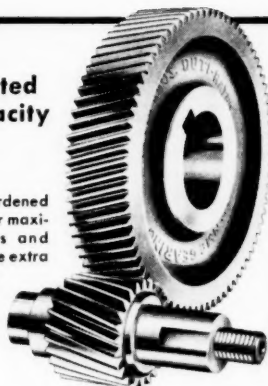
This extension to the Wagner line provides compact motorized drives, with both motor and gear housing of corrosion-resistant cast iron. Available with the latest NEMA Frame open protected or totally enclosed fan-cooled motors, they combine Wagner motor dependability with rugged, simplified gear units to give you speed reduction equipment designed for greater capacity and longer life in ordinary up to rough service.

Wagner Gearmotors offer a wide variety of sizes in single, double, triple or quadruple reductions, horizontal or vertical foot or flange mountings—speeds from $7\frac{1}{2}$ to 780 RPM. Write for Bulletin MU-227.

Whether you specify or apply power transmission equipment, your nearby Wagner Sales Engineer will be glad to help you select the right drive for your applications.

Heat treated high capacity helical gears

Gears are hardened after cutting, for maximum hardness and accuracy, to give extra capacity and longer wear life.



Positive Oil Seals



Improved lip type seals are used on horizontal shafts. On vertical output shafts, double mechanical seal with slinger and drain-off gives positive protection against leakage.

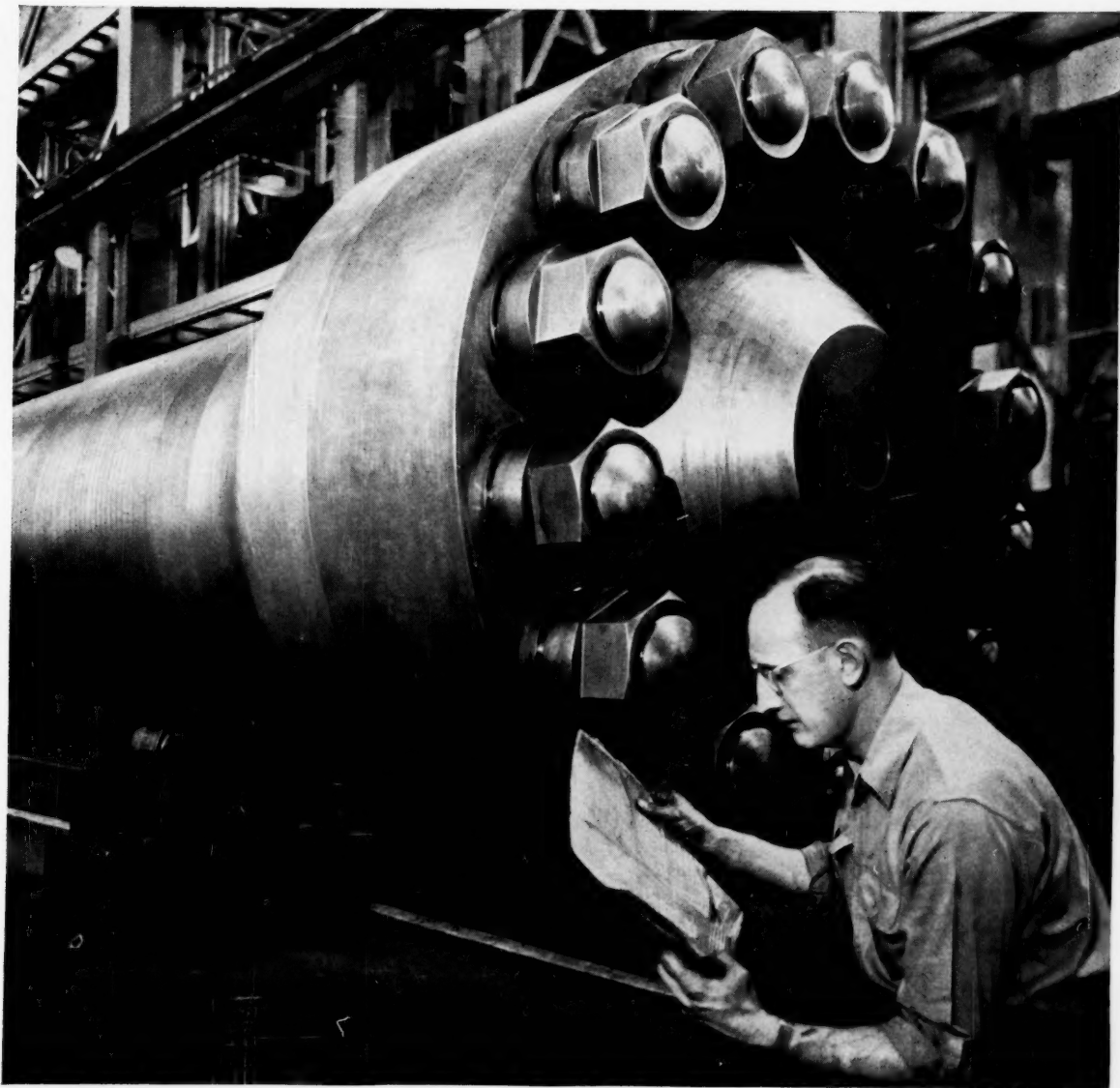
BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

WH59-12

Wagner Electric Corporation

6407 Plymouth Ave., St. Louis 14, Missouri.

SERVING 2 GREAT GROWTH INDUSTRIES...ELECTRICAL...AUTOMOTIVE



Strong, Seamless Walls 7½ in. Thick

This forged Bethlehem converter, built for use in the making of ammonia, weighs 48 tons. Much of the weight is in the rugged seamless walls, which are solid steel, 7½ in. thick. Those walls are built to contain high pressures, and they will do the job.

Another interesting feature is the circle of huge nuts that hold the

vessel's head to the body. Each of them weighs 77 lb and has a diameter of 10 in. There are 14 nuts and matching studs — convincing evidence of the pressures to be handled.

This could be called a typical Bethlehem vessel of medium weight. Our shops are equipped to build both larger and smaller models of autoclaves, reactors, filters, con-

verters, separators, and high-pressure accumulators. Whatever your needs, Bethlehem can meet them—at competitive prices. Deliveries are prompt. Write for details.

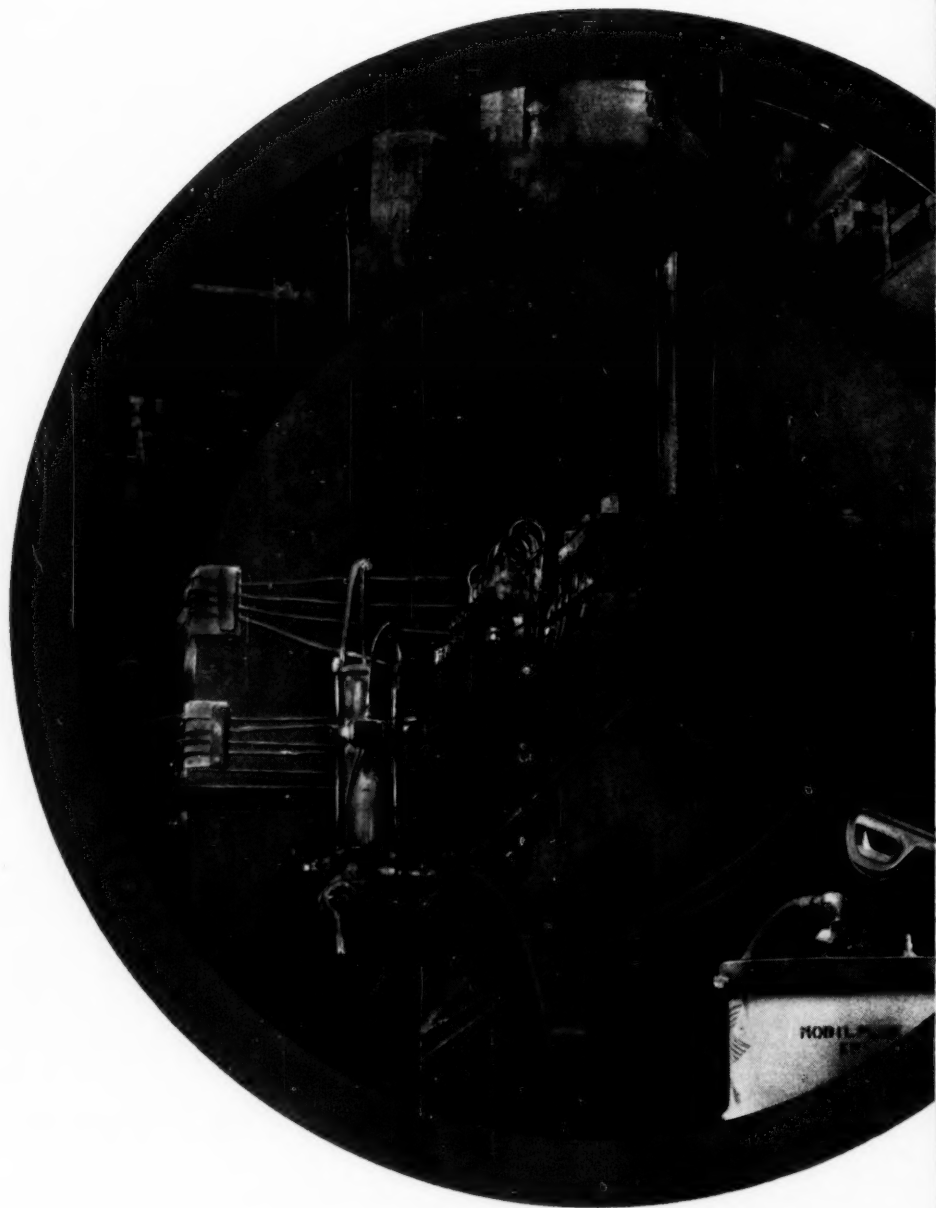
BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL



Mobilplex ep



The Multi-Service Grease with unique Calcium EP Complex. Never before in a single lubricant such a wide range of use . . . such a margin of superiority . . . such a potential for maintenance savings.

Outstanding load-carrying ability is one of the many important properties of Mobil's new Multi-Service Grease — Mobilplex EP. In your washing, breakdown, mixing and calendering operations, you'll find Mobilplex EP offers maximum protection against heavy and shock loads. It also offers excellent resistance to heat and extra protection against water and rust.

This Multi-Service grease has outstanding oxidation resistance as well as excellent structural and storage stability. These qualities—plus the great versatility of Mobilplex EP—make it useful throughout the plant.

Plant operators throughout the country are finding Mobilplex EP extremely effective in extending bearing life and protecting production schedules. In addition, they're saving more than with ordinary multi-purpose greases because Mobilplex EP makes it possible to reduce application frequency, simplify storage and handling procedures.


Contact your Mobil representative for full details. He can show you results of laboratory performance tests of Mobilplex EP and five leading competitive extreme-pressure greases. You'll see why Mobilplex EP is rated tops!


MOBIL OIL COMPANY, A Division of Socony Mobil Oil Company, Inc.


Above: Mobilplex EP produces excellent results in Timken OK-Load tests, provides outstanding performance in heavy-duty equipment.

Heavily loaded bearings like this grease-lubricated bearing of a Farrel-Birmingham Banbury mixer last longer, require less maintenance with Mobilplex EP.

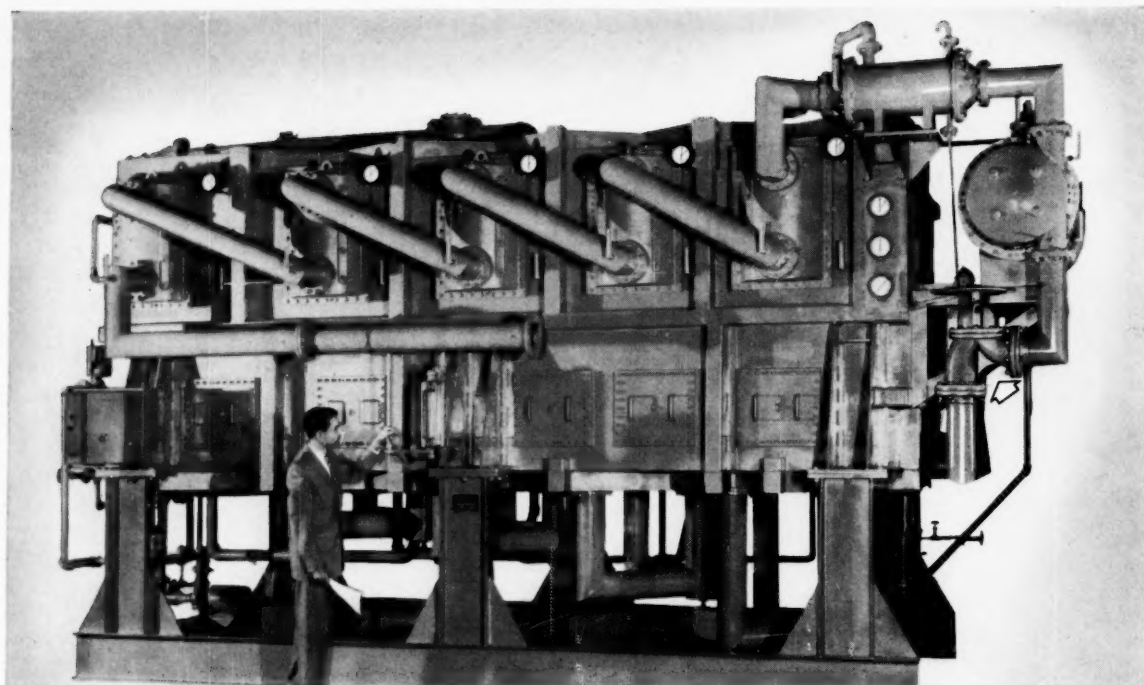
MULTI-SERVICE ABILITY OF MOBILPLEX EP

ANTI-FRICTION BEARINGS  (horizontal and vertical). Temperatures in the range of 300 F. Heavy or shock loads. Water contamination. Speeds—low, normal, high.

PLAIN BEARINGS  All normal mechanical and operating conditions. Temperatures in the range of 300 F. Waterwash. Heavy or shock loads.

DISPENSING AND APPLICATION DEVICES  Transfer pumps. Hand and power guns (long lines). Central greasing systems.

Mobil



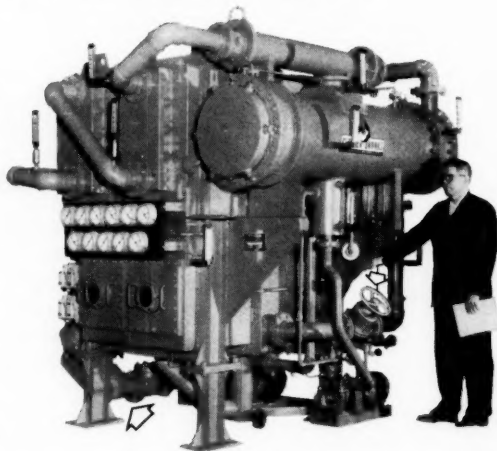
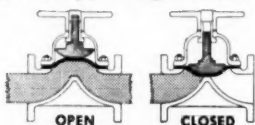
ON LAND At Salinas, a tourist center in Ecuador, this Cleaver-Brooks Flash Evaporator delivers 50,000 gallons of pure, distilled water every 24 hours. It is equipped with two 6", rubber lined, weir-type Grinnell-Saunders Diaphragm Valves — only one of which can be seen from this view.

Grinnell-Saunders Diaphragm Valves help convert salt water to fresh water

You can convert sea water to fresh water, in abundant supply, on land . . . or on shipboard, with flash evaporators made by Cleaver-Brooks Special Products, Inc., Waukesha, Wisconsin. Grinnell-Saunders Diaphragm Valves are used as original equipment on these distillation units because they offer positive, leak-tight closure; flow control in throttling position; corrosion-resistance.

You'll find Grinnell-Saunders valves widely used in other fields, too . . . petroleum, papermaking, chemical, food, compressed air . . . to mention a few.

The operating principle of the Grinnell valve is the feature which makes it so adaptable. The diaphragm lifts high for streamline flow in either direction; seals tight for positive closure against grit, scale, solid matter, pressure or vacuum. Bonnet mechanism is completely isolated at all times from the fluid in the line by the diaphragm, preventing corrosion and contamination. Smooth passage, without pockets, eliminates trapping of solids and reduces frictional resistance. And you can get body, lining and diaphragm materials to meet your particular service conditions. Get *all* the facts. Write Grinnell Company, Providence 1, R. I.



AT SEA The nuclear powered NS Savannah has two 16,000 gallons-per-day Cleaver-Brooks distillation units to supply the entire water requirements of crew and machinery. Each unit has two 4" Grinnell-Saunders Straightway Valves of ductile iron.

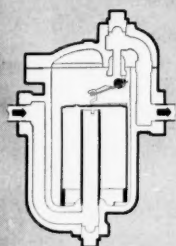
GRINNELL



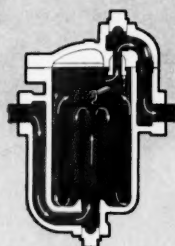
Pipe, Fittings, Valves, Hangers, Heating and Piping Supplies
Branch Warehouses and Distributors From Coast To Coast

December 14, 1959—CHEMICAL ENGINEERING

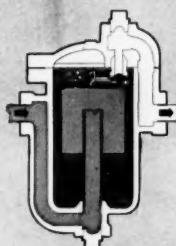
This simple trap operating principle provides the efficiency, dependability and freedom from maintenance necessary for the most profitable use of steam



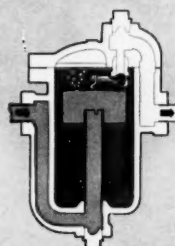
When trap is first installed, the inverted bucket is down and the valve is wide open.



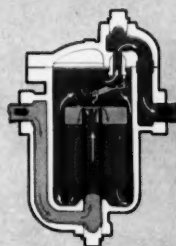
When steam is turned on, condensate (solid color) flows into trap and out through discharge orifice, until —



Steam (light color) reaching the trap floats the inverted bucket and closes the valve.



When more condensate enters the trap, the bucket loses buoyancy and pulls on valve lever.



When weight of bucket times leverage overcomes pressure on valve, bucket sinks and opens trap.

Key: condensate steam steam bubbles air bubbles

ARMSTRONG INVERTED BUCKET STEAM TRAPS

are designed and made to give you these big benefits:

● Armstrong Traps, the first inverted bucket steam traps, now represent the most advanced development of this time-proven principle. They provide all the advantages necessary for efficient, economical condensate drainage from virtually all types of steam using equipment.

1. *No steam loss* — Steam never reaches the orifice even when there is no condensate load.
2. *Automatic air elimination* — Vent in trap bucket passes air and other non-condensibles through to be discharged with condensate.
3. *No cooling leg required* — Condensate is discharged at steam temperature as fast as it reaches the trap because trap operates on difference in density between steam and water not on temperature.
4. *Operates on any back pressure* — Failure of one trap in system will not cause others to open because high back pressure does not affect an Armstrong trap other than to reduce capacity. As long as there is a

pressure differential across the orifice the trap will close on steam and open for condensate.

5. *Unaffected by ordinary dirt* — Swirling action of condensate keeps dirt in suspension until discharged with condensate, prevents it from lodging in valve.
6. *Completely dependable* — Proved design plus the use of all stainless steel working parts assure continuity of service and length of service unmatched by any other trap.
7. *Big capacity in a small, economical package* — Armstrong design gives you the highest practical capacity for any given pressure. And remember, Armstrong capacity ratings are based on *hot* condensate at the *working pressure differential* stated, not on theoretical orifice capacities.

Further information on these advantages plus much additional information is given in the 48 page Armstrong Steam Trap Book. Ask your local Armstrong Representative or write direct.



860 Series for low pressure heating service.



800 Series, side inlet, side outlet.



No. 801, side inlet, bottom outlet.



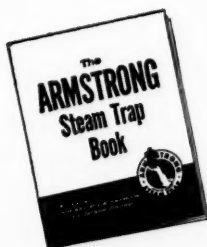
880 Series, integral strainer.



200 Series, bottom inlet, top outlet.



Forged Steel Series for high pressures, high temperatures.



The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.



ARMSTRONG MACHINE WORKS

5854 Maple Street • Three Rivers, Michigan

BRIEFS

on some recent developments in sodium chlorate...an easy way to get benzyl groups...what to look for in muriatic acid specs

Keeping up with the sodium chlorate demand



There has been such a surge of interest in sodium chlorate during the past few years that we have had the happy obligation of expanding our facilities three times.

The most recent addition has been onstream at our Columbus, Mississippi plant since February of this year.

This more than doubles the capacity this plant started with in 1954. Of course, in addition we also have large production facilities at our Niagara Falls location.

Much of this new tonnage is going into chlorine dioxide generation. As you probably know, the pulp and paper people are mostly responsible for this, but there is growing interest in other areas also.

New drum empties faster. Recently we introduced this new drum style on our sodium chlorate. A single lever seals and reseals the drum with a metal band. The full head area is opened for use. The old-style drum had a smaller opening and required the manipulation of four lugs for sealing. The new drum comes in 100 and 400-lb. net weights.

Data for your files on our sodium chlorate are offered in the coupon.



What to look for in muriatic acid specs

This white gummy substance is an insoluble precipitate which can form in certain reactions with muriatic acid that contains too much sulfate.

Iron, arsenic, and free chlorine can also give a process indigestion when their level in muriatic acid is too high.

So it pays to consider these carefully when you examine any muriatic's specs.

Take Hooker White Grade muriatic, for example. Iron: a mere 0.0001% at the most. Sulfates: less than 0.003%. Free chlorine: none. Arsenic: none.

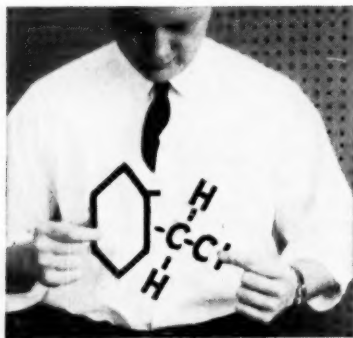
This Hooker White Grade is probably the purest muriatic you can buy anywhere in volume.

Very often your process can stand a little higher level of these impurities.

Hooker Commercial Grade offers these maximum specs: Iron: a low 0.0005%. Sulfates: 0.003%. Free chlorine: a slight trace. Arsenic: none.

Both grades are delivered in rubber-lined tank cars. Both are available in three strengths: 18°, 20°, and 22° Baumé.

For more complete technical data, check the coupon. And, if you'd like samples of either grade, just write us on your business letterhead to speed delivery.



Handy way to get benzyl groups

If you want to tag benzyl groups onto some compound you're working with, we offer for your inspection Hooker benzyl chloride.

Here's a compound that's been around some time, so we have no trouble making it to specs in short time in any quantity.

The benzyl group of the compound reacts readily and can be easily led to

fit into your own formulation.

The benzyl chloride we make is a clear liquid, colorless or light yellow to the eye. It has a characteristic pungent odor. It's insoluble in water but dissolves readily in alcohol and ether.

If you'd like a look at our specifications and typical data, we ask only that you fill out the coupon and send it to us.

We have a very similar story to tell on benzoyl groups as we make benzoyl chloride, too. So we also offer data on this chemical in the coupon.

For more information, check here and mail with your name, title, and company address.

- ☐ Sodium Chlorate ☐ Benzoyl Chloride
☐ Benzyl Chloride ☐ Muriatic Acid

When requesting samples, please use business letterhead to speed delivery.

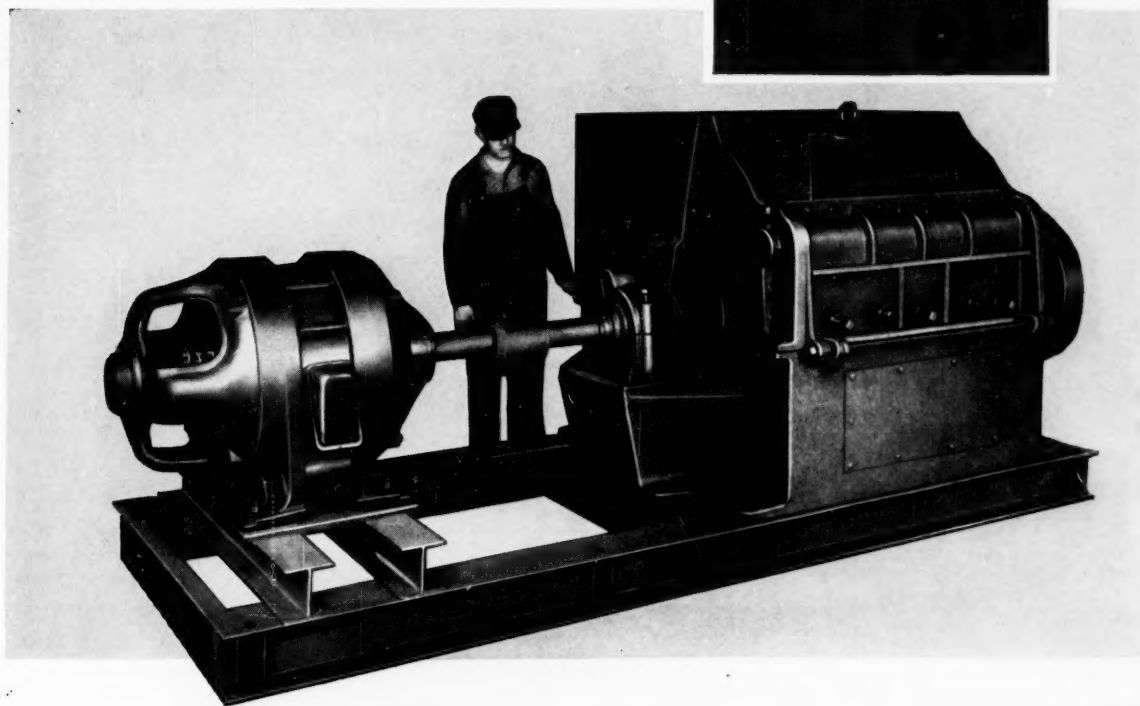
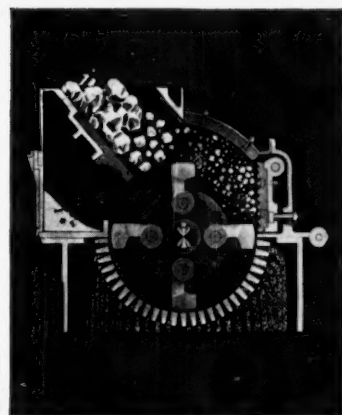
HOOKER CHEMICAL CORPORATION

412 FORTY-SEVENTH STREET, NIAGARA FALLS, N. Y.

Sales Offices: Chicago Detroit Los Angeles New York
Niagara Falls Philadelphia Tacoma Worcester, Mass.
In Canada: Hooker Chemicals Limited, North Vancouver, B. C.

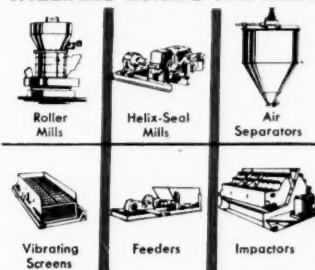


**Complete size reduction...
from start to finished product...
in a single Williams Hammer Mill**



Cut costs as much as 50% on production... up to 75% on equipment

WILLIAMS BUILDS THE BEST



In all normal crushing operations, a Williams heavy duty hammer mill can take most material and, in a single pass, reduce it to finished size! Production economies alone, in labor, power, maintenance, as well as stepped up output of better quality and more uniform products, will cut costs up to 50%.

Savings in original installations, as high as 75%, can also be expected. By making primary and secondary crushers unnecessary, a Williams hammer mill will eliminate all extra con-

veyors, drives, other equipment, special foundations and additional housing.

Williams hammer mills are built for daily rough and rugged service. Extra heavy manganese steel liners and breaker plates, oversize shafts, massive parts and reinforcements, all defy shock and wear, reduce downtime and replacements to nil.

If the cost price squeeze is one of your problems, get the facts about Williams hammer mills. Write now for catalog.

WILLIAMS
CRUSHERS GRINDERS SHREDDERS

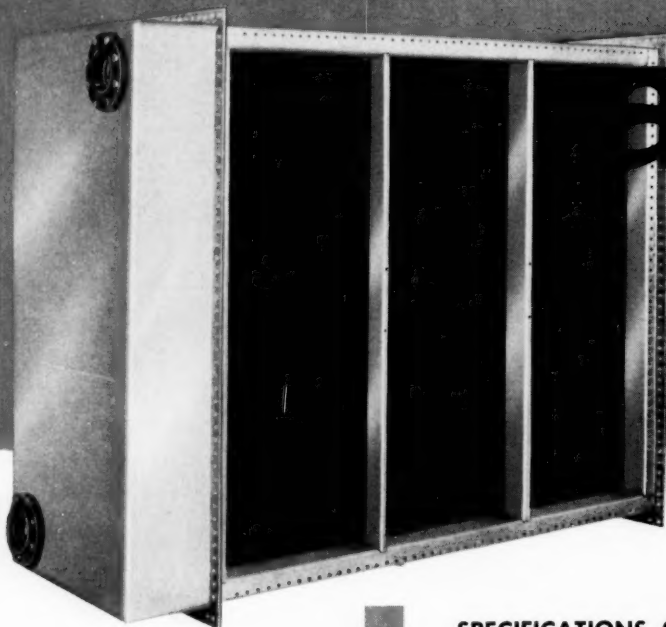
Oldest and Largest Manufacturers of Hammer Mills in the World

PATENT CRUSHER & PULVERIZER CO.
2706 N. 9th St. St. Louis 6, Mo.



Marlo

Liquid / Gas Heat Exchangers



any

**APPLICATION,
ALLOY,
OR SIZE**

Write or Phone
for Additional
Information for
Your Application.

SPECIFICATIONS ON THIS UNIT:

MATERIAL: 316 ELC Stainless Steel

Face Dimensions: 60" x 72"

Overall Dimensions: 98" x 68" x 30"

TUBES: 0.035" wall, 5/8" O.D.

Spacing: 1 1/2" center to center, staggered

FINS: 0.010" plate type with die-formed ferrules

Spacing: 8 per inch

SURFACE: Total: 10,650 sq. ft.

Primary: 558 sq. ft.

CASING: Air tight at 60 inches W. G.

OPERATING PRESSURE: 1500 p.s.i.

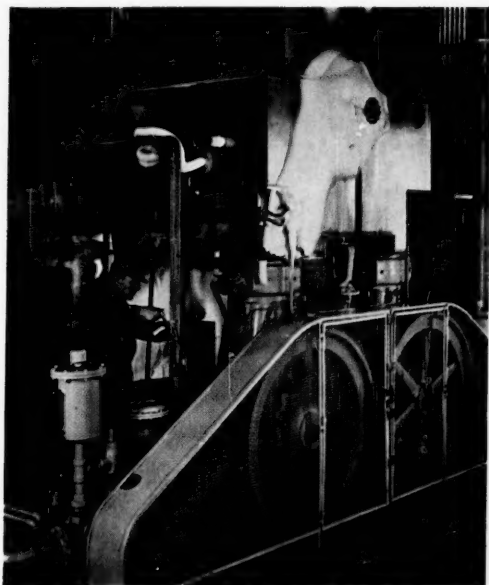
WEIGHT: 5100 lb. dry

Marlo coil co.

SAINT LOUIS 11, MISSOURI

Quality Air Conditioning and Heat Transfer Equipment Since 1925

EXPANSION ENGINES TO PRODUCE LIQUID HELIUM AT MINUS 452 F



↑ Vertical single cylinder expansion engines on helium separation service. Hydraulic power absorption system permits quick and accurate response to flow changes.

To build a machine to operate at temperatures just 7.4 degrees above absolute zero requires skill and experience. Temperatures below—400 F are not new to Worthington. Worthington has already engineered expansion engines to operate at—422 F. Worthington has completed extensive engineering work to meet the operational problems encountered at the liquefaction temperature of helium.

As a natural result of this low temperature work, Worthington now offers reciprocating expansion engines for the demanding job of helium liquefaction. For a documentation of Worthington's experience in the expander field, please turn the page.







Typical applications for Worthington expanders

GAS	LIQUEFACTION TEMPERATURE (Atmospheric Pressure)		
	Fahrenheit	Centigrade	Kelvin
METHANE	—258.5	—161.4	111.7
OXYGEN	—297.4	—183.0	90.1
AIR	—317.6	—194.2	78.9
NITROGEN	—320.4	—195.8	77.3
HYDROGEN	—422.9	—252.7	20.4
HELIUM	—452.0	—268.9	4.2





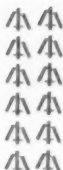

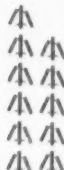
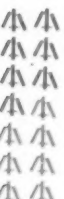




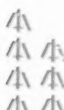
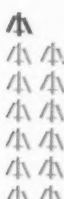



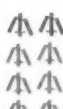







Horizontal single cylinder expansion engine on air separation service. Powerful frame and tough, yet precision valve mechanisms assure high engine reliability.



KEY

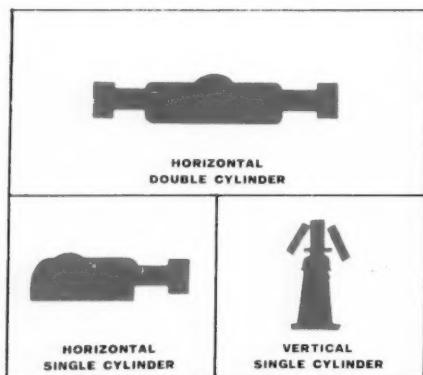
 0 to -100 F
  -251 to -300 F
 -101 to -250 F
  -301 F and colder

(Includes both vertical and horizontal units)

1929	1930	1931	1932	1933	1934	1935	1936
							
							
1937	1938	1939	1940	1941	1942	1943	1944
			1948				1952
1945	1946	1947	1948	1949	1950	1951	1952
	1954						
1953	1954	1955	1956		1957	1958	1959

30 years and 307 expanders later...

WORTHINGTON IS THE WORLD'S LARGEST BUILDER OF LOW-TEMPERATURE RECIPROCATING EXPANSION ENGINES



3 basic designs to choose from

The illustration above pictures Worthington's broad range of experience in the low-temperature reciprocating expander field. (Supplementing this is Worthington's long experience in high and low-temperature turbine expanders.)

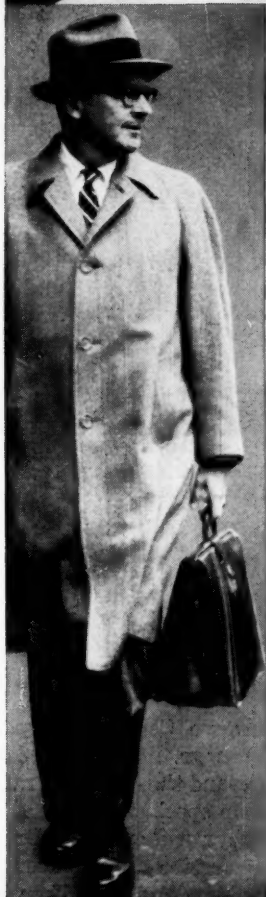
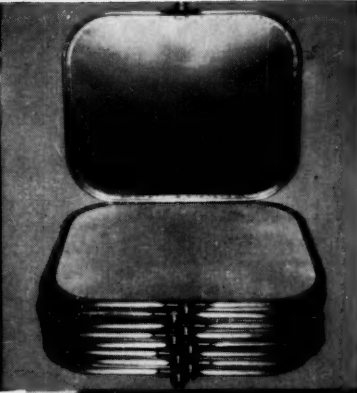
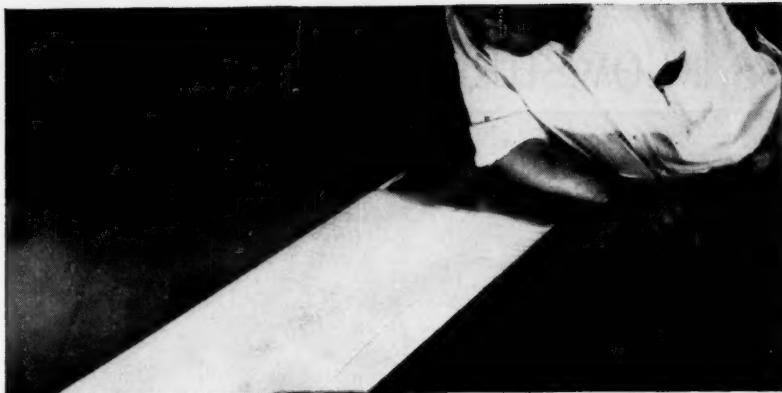
An expansion engine is not just a reverse compressor. It must have a powerful frame to handle pressures of several thousand lbs. per sq. in. The valve gear also requires special consideration. Several years ago Worthington developed a patented valve gear with remarkable durability. Operating under loads which sometimes exceed several tons, valve gear failures are almost non-existent.

Many expander applications call for

non-lubricated construction. Worthington has successfully built many such units. Worthington also makes all types of units, in both horizontal and vertical designs, to handle every expander application.

Want more information? Send for your copy of a new 8 page expander bulletin. Write to: Worthington Corporation, Section 36-6, Harrison, N. J. In Canada: Worthington (Canada) Ltd., Brantford, Ont.





Who makes and meets your Wire Cloth Specs?

CAMBRIDGE does . . .

To assure you of wire cloth fabrications that give long and satisfactory performance, we have experienced engineers who can draw up prints for your approval if necessary, and trained production men who can quickly and accurately fabricate parts to your most rigid specifications.

To fill your most diversified bulk wire cloth needs, we have thousands of items in stock—in all meshes, wire sizes, metals or alloys—ready for prompt delivery.

Modern machinery, careful workmanship and constant inspection assure you of exact mesh count and mesh size. And, our field engineers follow up your order to see that our product is giving the best possible service.

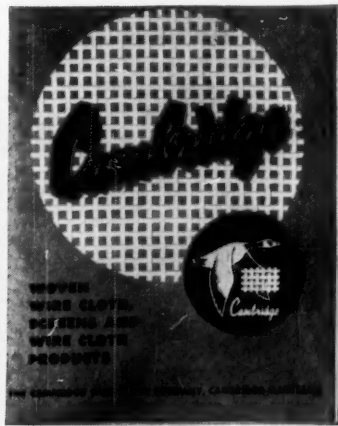
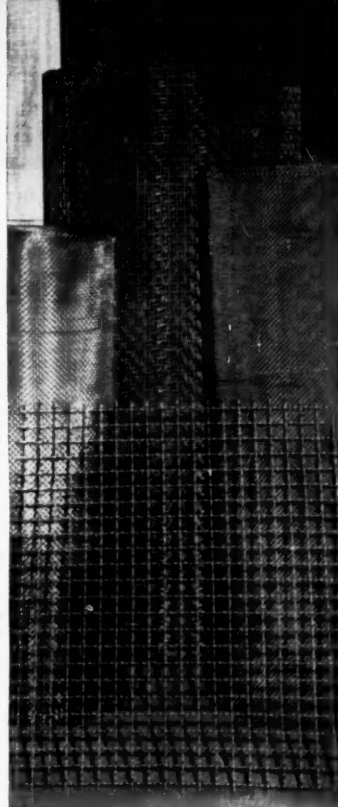
We make wire cloth from any metal or alloy—including titanium—in nine basic weaves—from finest to coarsest mesh. Call your Cambridge Field Engineer for information. He's listed in the yellow pages under "Wire Cloth". Or, write for **FREE 94-PAGE CATALOG.**



**The Cambridge
Wire Cloth Co.**

Department G • Cambridge 12, Md.

Manufacturers of Wire Cloth,
Metal-Mesh Conveyor Belts, Wire Cloth Fabrications



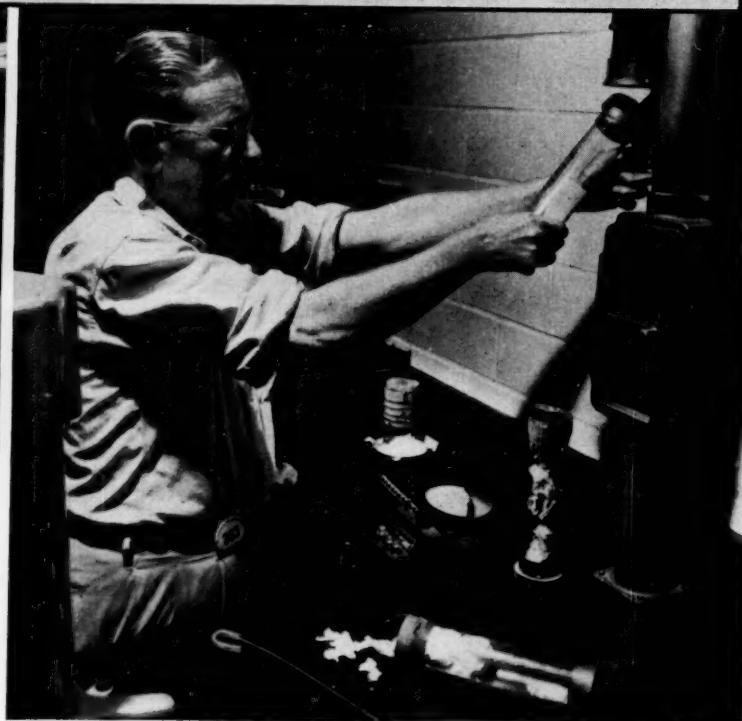
DEVELOPMENTS ...

PROCESS FLOWSHEET

R. A. LABINE



Hand sorting of logs, taking 1,000 samples per day are only two of many quality controls in making chemical cellulose.



Tyrex Fibers Dictate Pulping Changes

Making today's high-quality, chemical-grade cellulose for products like Tyrex tire cord and wash-and-wear rayon requires many modifications of the well-known pulping processes. This is

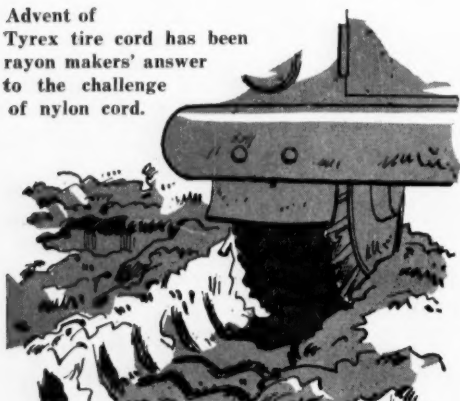
graphically shown at Buckeye Cellulose Corp.'s new Foley, Fla., 200,000-ton/yr. mill where \$20 million has been spent to expand the existing kraft process to meet modern pulp specifications.

Quality control is the byword at Foley. During initial steps, extreme care is taken to assure clean, uniform chip feed to the digesters. Then in subsequent stages, uniform digestion and meticulous mechanical and chemical upgrading assures final pulp quality.

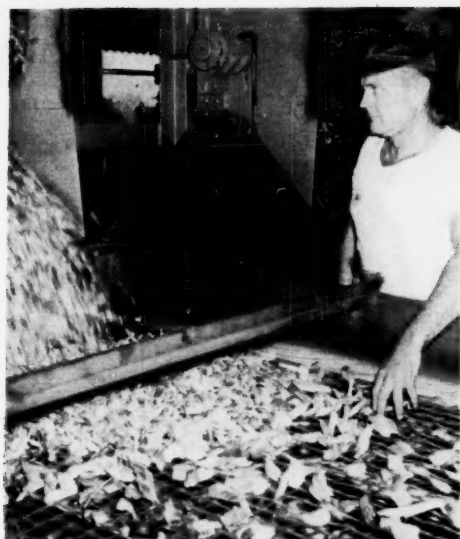
► **Quality Starts With Wood**—At present output rate, Foley processes about 3,800 tons/day of pulpwood.

Buckeye takes particular care to debark logs cleanly in conventional barking drums. Any hardwood logs that retain bark make a second pass through a newly designed hardwood debarker.

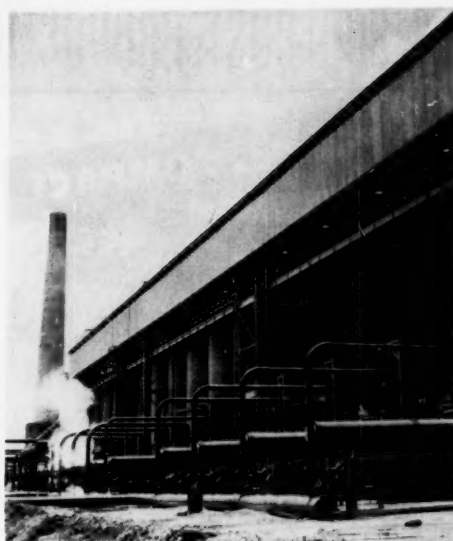
Advent of Tyrex tire cord has been rayon makers' answer to the challenge of nylon cord.



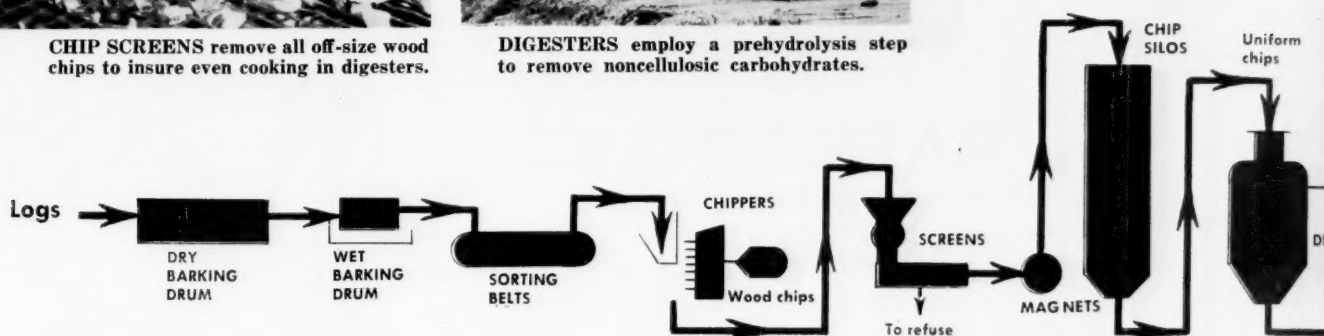
Unfold Flowsheet



CHIP SCREENS remove all off-size wood chips to insure even cooking in digesters.



DIGESTERS employ a prehydrolysis step to remove noncellulosic carbohydrates.



Either pine or hardwood logs that still carry traces of bark are hand manicured as they travel along a slow-moving flat conveyor belt; rotten or burned logs are routed to bark hog for grinding into boiler fuel.

Clean logs feed into chippers which reduce them to nominal $\frac{5}{8}$ -in. chips. Screening removes off-size small and large chips which would digest faster or slower than standard chips, reducing uniformity of the pulp. Off sizes go to the boilers; standard chips go to silos for holdup during determination of moisture content.

► **Digest by Stages**—Once moisture content is known, chips are loaded into one of 14 digesters, each holding 50 tons. Moisture content of the chips

governs weight of chips charged to each digester in order to hold chemical-wood ratio constant for uniform digestion.

Two-stage digestion uses a modified kraft process to maximize removal of noncellulosics. During first or prehydrolysis stage, chips are steamed at 110-125 psi. Noncellulosic carbohydrates, chiefly pentosans and mannan, hydrolyze and drain to bottom of digester for removal when steaming terminates.

In the second stage, digestion with kraft liquor removes lignin and low-D.P. (degree of polymerization) carbohydrates. By varying the temperature, time and alkali concentration of the cooking liquor, the operators can control delignification and viscosity of the pulp.

Removal of 80-85% pentosans during prehydrolysis opens up the fiber structure to facilitate xanthation in the viscose process. It also enables second-stage cooking liquor to penetrate more rapidly and completely.

► **Unique Double Screening**—After digestion, pulp is washed free of black liquor and it passes through a double screening which Buckeye believes is unique.

Passing through vibrating plates with 1/16-in. openings behind undigested chips. Then a series of cyclones remove the thinnest shives to produce clean pulp.

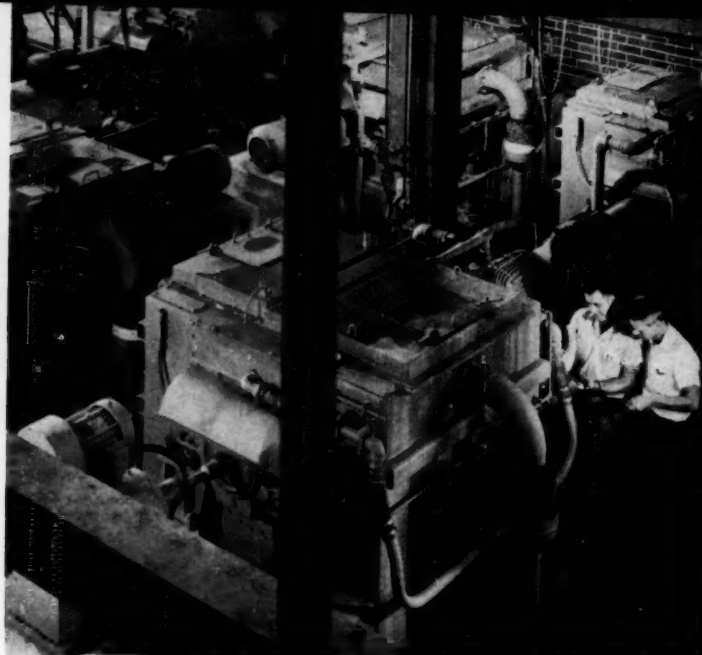
► **Bleaching Secret**—Buckeye's bleaching stages, pulp goes through a series of stages. From here on, all equipment is glass, or lined with plastic to prevent contamination.

Buckeye's bleaching is unique, both for its ability to bleach and its procedures. Starting with a kraft bleach plan, Buckeye has added more stages to meet standards.

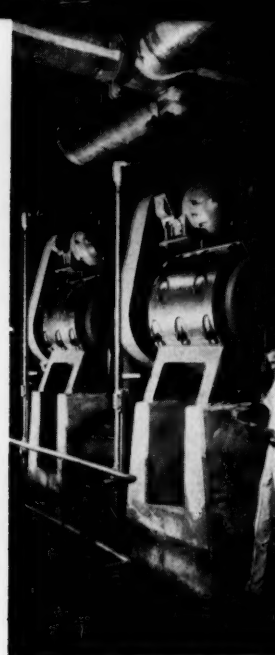
Most bleaching is merely pointing to break molecular chains while cold caustic soda removes mannan and other impurities. The final step removes lignin, making the pulp

How Tyrex Has Tightened Pulp Specifications

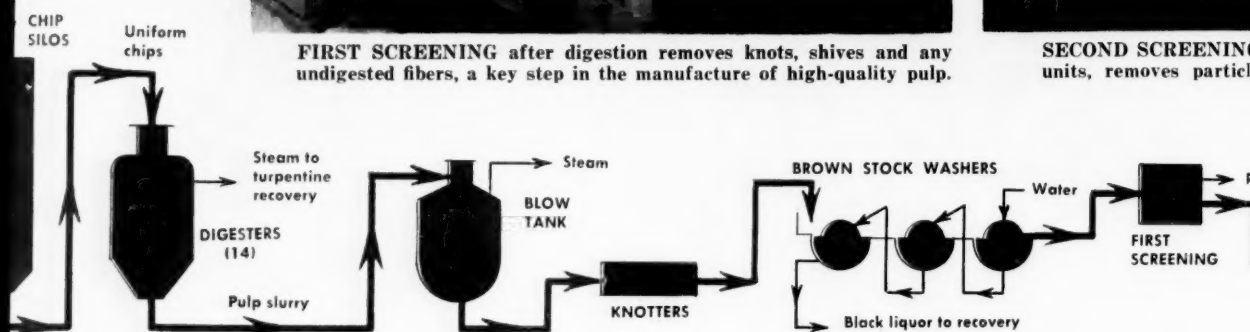
	Rayon	Tyrex
Alpha cellulose.....	94-96%	97.4%
Beta cellulose.....	2.3-3.0%	1.6%
Gamma cellulose.....	1.5-3.5%	1.0%
Ash.....	0.04-0.08%	0.04%
Silica.....	40-200 ppm.	25 ppm.
Calcium.....	100-300 ppm.	10 ppm.
Iron.....	5-15 ppm.	66 ppm.



FIRST SCREENING after digestion removes knots, shives and any undigested fibers, a key step in the manufacture of high-quality pulp.



SECOND SCREENING units, removes particles...



Passing through the first set of screens, vibrating plates with small slits, the pulp leaves behind undigested fiber bundles, knots and shives. Then a series of centrifugal screens removes even the thinnest shives remaining to give an extremely clean pulp.

► **Bleaching Secrets**—Before entering the bleaching stages, pulp goes to a stock chest for blending. From here on, all equipment is stainless steel, glass, or lined with tile or rubber to prevent metallic contamination of pulp.

Buckeye's bleaching setup is considered unique, both for its number of stages and for its ability to bleach pulp by any of the known procedures. Starting with a conventional eight-stage kraft bleach plant, Buckeye has modified it and added more stages to satisfy modern purity standards.

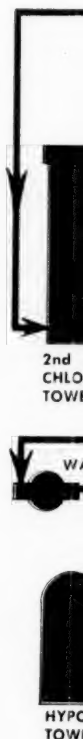
Most bleaching details are confidential, Buckeye merely pointing out that it uses hypochlorite to break molecular chains and reduce viscosity while cold caustic extraction dissolves pentosans, mannan and other low-D.P. materials. A "sour" step removes minerals, sets the white color and makes the pulp more reactive. (Bleach plant

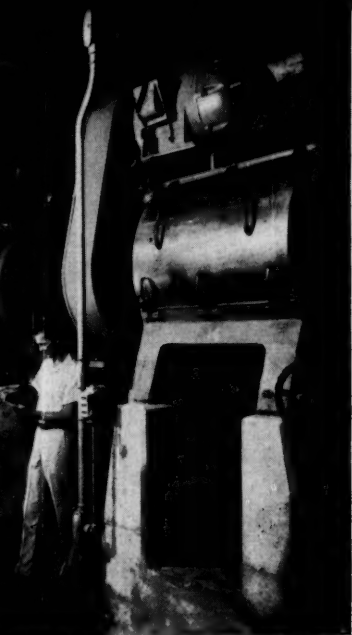
shown in the flowsheet is only for paper pulp.)

To maintain uniform quality, the operators control within narrow limits the pH, concentration and temperature of all bleaching liquors. Viscosity and brightness are checked several times during the bleaching operation.

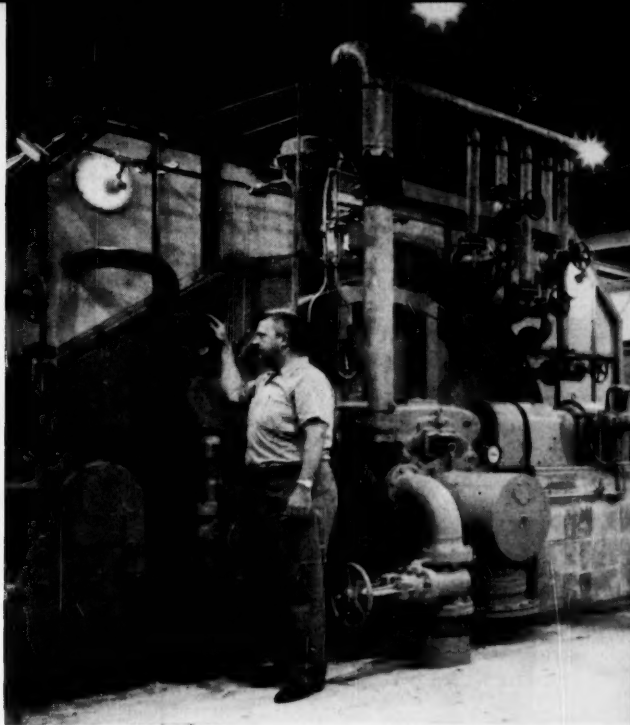
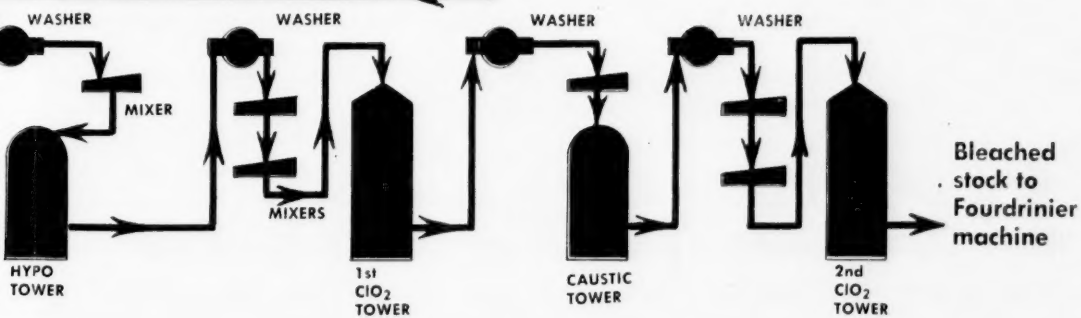
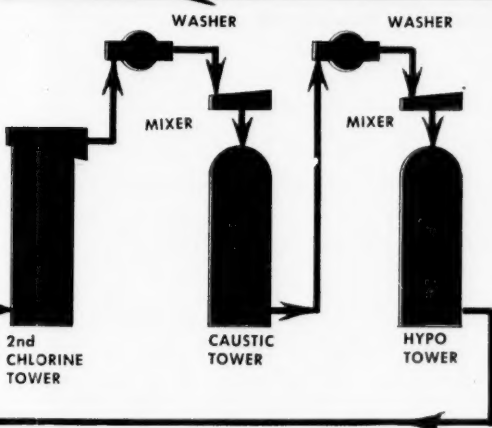
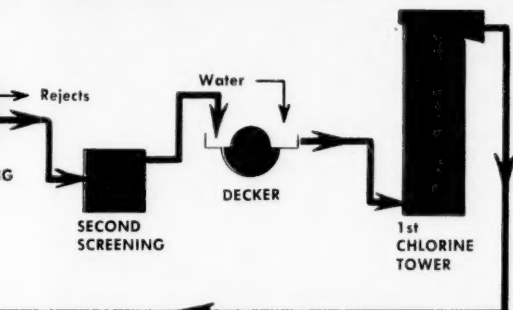
► **No Letup At End**—Among the important final pulp quality safeguards are:

- Pressurizing of bleach plant and sheet-forming room with filtered air to prevent contamination of pulp by air-borne particles.
- Washing with water, containing less than 2 ppm. total hardness, following "sour" stage to prevent mineral pickup. Similar demineralized water is used from here to end of process.
- Leveling of variations through blending in bleached stock chest.
- Use of special distributor box on Four-drinier sheet-forming machine to assure even formation which is essential to uniform penetration of chemical into pulp during viscose manufacture.
- Storage of jumbo rolls until lab OK's for shipment.
- Sheet cutting pairs of rolls into uniform bales.

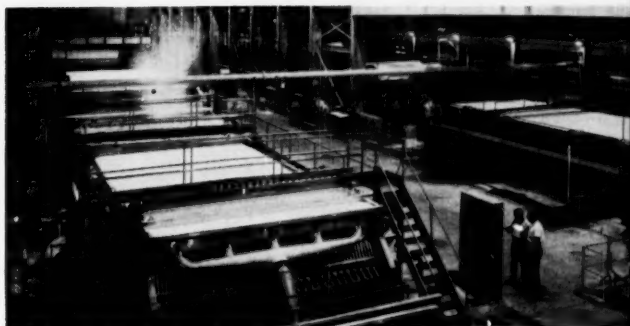




NING, carried on in these centrifugal articles that escaped first screening.



WASHERS in bleach plant are carefully regulated. Details of this bleaching step remain closely guarded secrets.



FOURDRINIER MACHINE'S feed box is supplied by a special manifold to insure even pulp flow onto drying belts.



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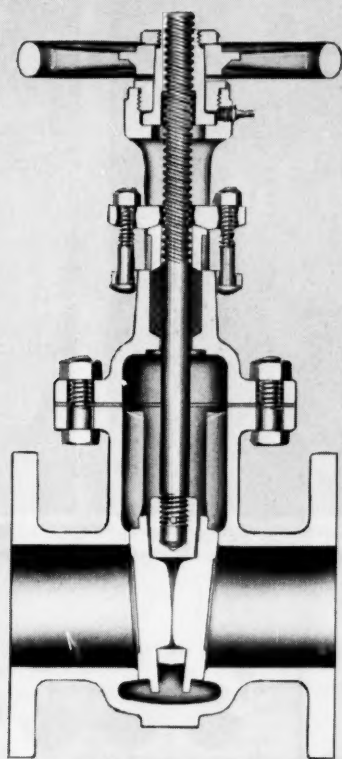
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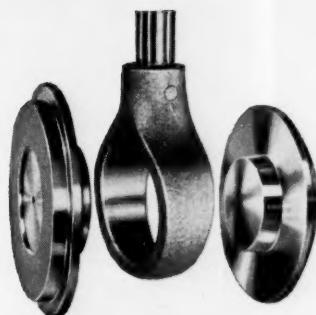
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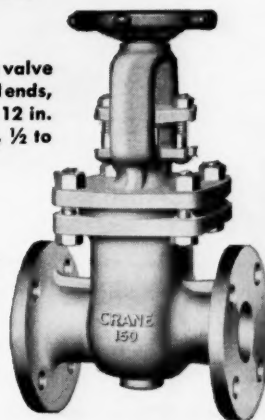


Sizes $\frac{1}{2}$ " to 12"; 150 psi at 500 F,
230 psi at 100 F



Crane split-wedge disc design. Identical disc halves assure uniform seating pressure.

18-8 SMO gate valve
—with flanged ends,
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Screwed ends, $\frac{1}{2}$ to
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This brochure gives you complete technical data on Crane 18-8 SMO and other stainless steel valves for substantial savings to fluid processors. Ask your Crane Representative for Bulletin AD-2411 or write to address below.



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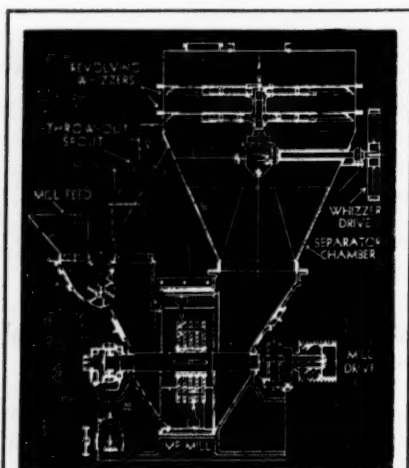
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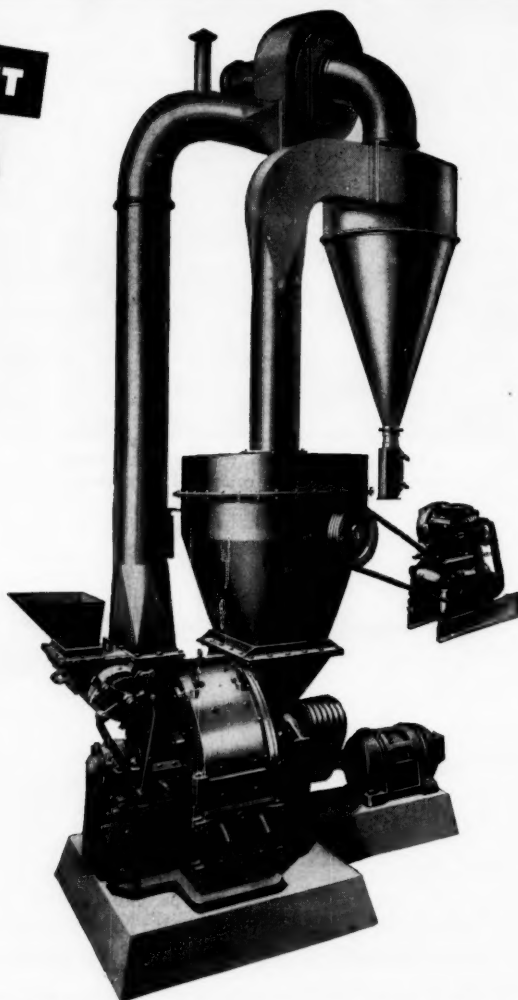
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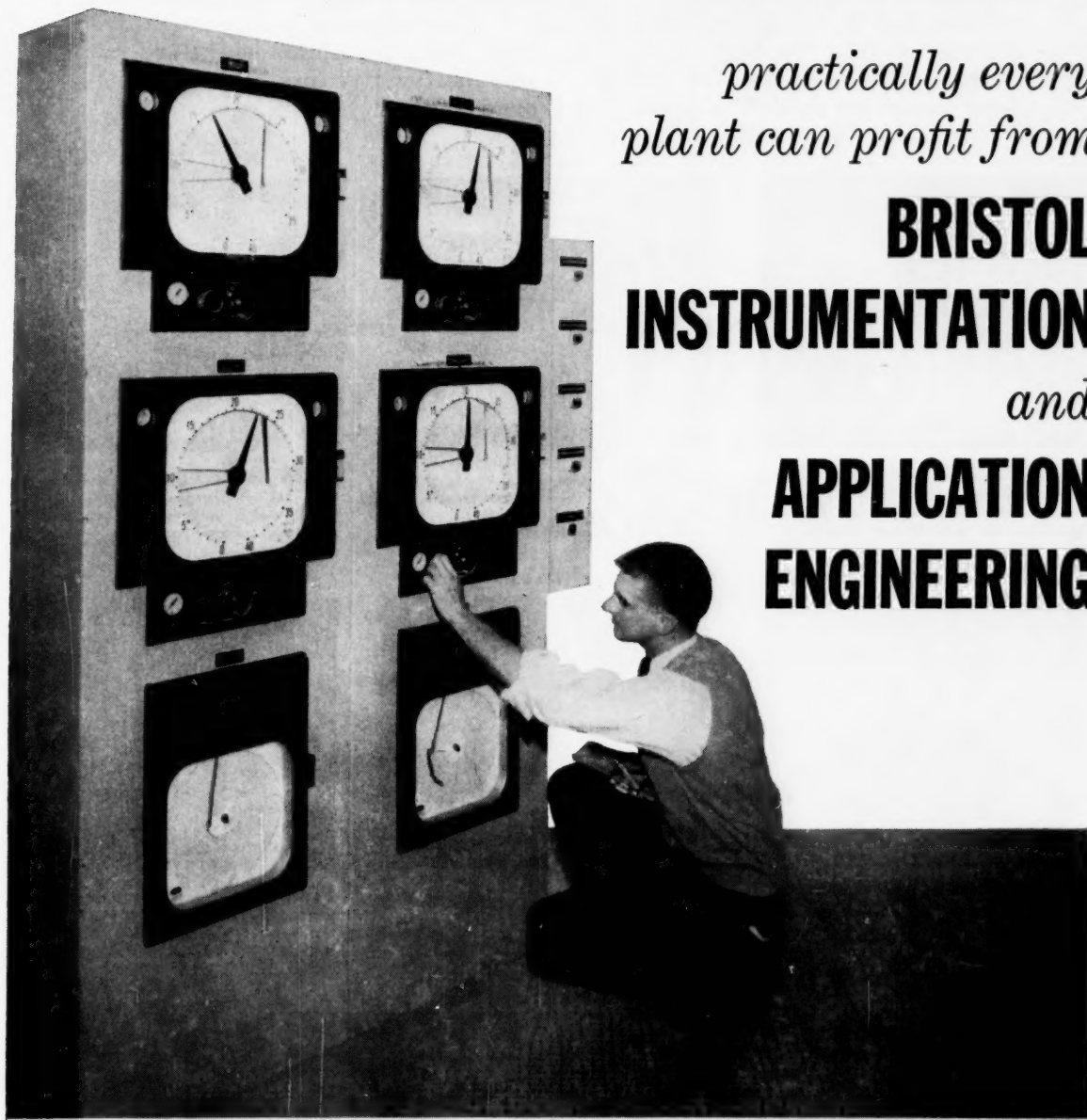
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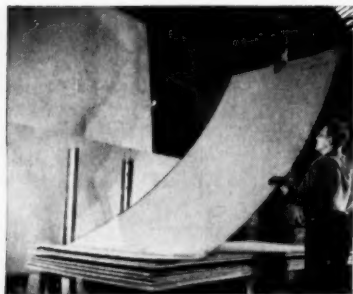
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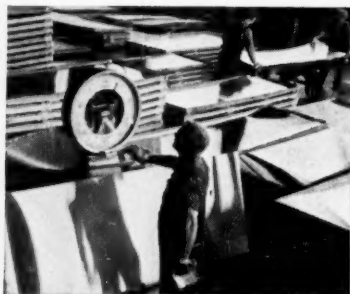
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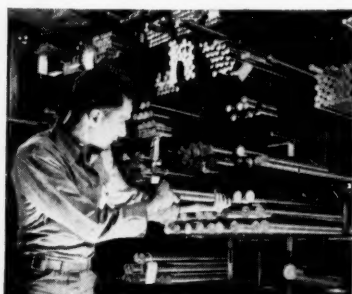
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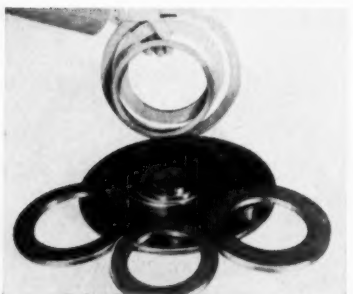
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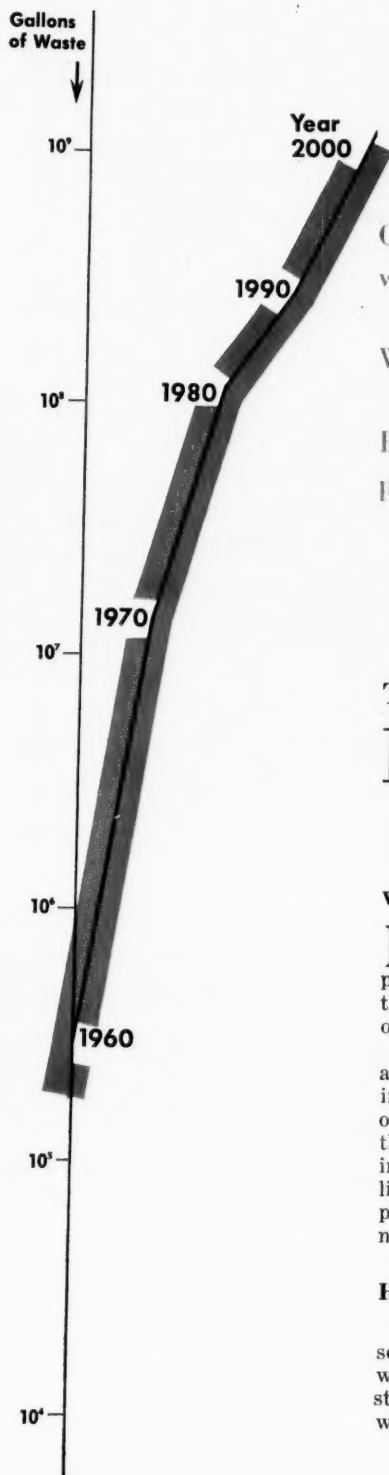


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One billion gallons of high-activity radioactive wastes by year 2000? It's possible.

We need some good disposal methods and soon.

Best bets so far: pretreatment by evaporation, precipitation, solid fixation; then land or sea burial.

Treating and Disposing of Radioactive Wastes

W. J. GEORGE, Wyandotte Chemicals Corp., Wyandotte, Mich.

HANDLING and disposing of radioactive wastes is a general problem whose thread runs through the entire fabric of nuclear energy operations.

Even at this early stage, we have a nation-wide, multipurpose nuclear industry with a capital investment of approximately \$7 billion. But as this industry expands, ever increasing quantities of gaseous, solid and liquid wastes will have to be disposed of in a safe, economical manner.

High-Level Liquid Wastes

The present situation is not too serious, with most of our nuclear wastes (mainly Government) in storage (Table 1). But this problem will become more and more critical

—our storage facilities are definitely limited.

Of principal importance, because of quantities involved and their extreme radioactivity, are the high-activity (or high-level) liquid wastes released in the chemical processing of spent nuclear fuels. We are going to restrict our discussion here to this type of waste. It presents a challenge to modern chemical engineering technology in devising safe, economical disposal methods which will not hinder future growth of peaceful nuclear power.

Chemical processing of reactor fuels is done to separate and recover unfissioned or unburned fuel from spent material. This usually means separating uranium, plutonium and fission products. The fission prod-

\$75-Million: A Big Storage Bill for Government Nuclear Wastes—Table I

	Hanford Atomic Products Operation	Savannah River Plant	National Reactor Test Station (ICPP)	Total
Amounts, through 1956				
High-level liquid waste in storage, gal.	58,200,000	3,500,000	380,000	62,080,000
Total tank capacity, gal.	90,000,000	12,200,000	1,600,000	103,800,000
Total number of tanks	145	16	9	170
Cost, tanks and appurtenances	\$37,500,000	\$16,600,000	\$6,600,000	\$60,700,000
Additional, to June 1959				
Additional wastes, gal.	9,100,000		1,500,000	10,600,000
Additional cost	\$7,000,000		\$6,500,000	\$13,500,000
			Total	\$74,200,000

Commercial Nuclear Capacity To Take Big Strides—Table II

Year	U. S. Nuclear Power Megawatts-Heat
1960	2,000
1970	33,000
1980	100,000
1990	300,000
2000	700,000

We Will Generate Millions of Gallon of Radioactive Nuclear Wastes by Year 2000—Table III

Year	Accumulated High-Activity Waste Generated (1,000 Gal.) Average Irradiation Level		
	2,000 Mwd./T.	4,000 Mwd./T.	10,000 Mwd./T.
1960	450	225	90
1970	22,000	11,000	4,400
1980	120,000	60,000	25,000
1990	400,000	200,000	80,000
2000	1,100,000	550,000	200,000

ucts are radioactive elements ranging in mass number from 70 to 162.

For solid-fuel elements, separation usually involves liquid processes—acid (usually nitric) solution of metal and cladding and solvent extraction to separate various components. Resulting liquid waste streams are quite dilute as far as mass concentration is concerned. But they contain radioactivity of up to several hundred curies per gal.

Storage Is Not Final Answer

In general, for every megawatt day (Mwd.) of nuclear heat generated, one gram of U-235 is consumed, producing approximately one gram of fission products.¹⁰

Table II presents one prediction

of future U.S. nuclear power generation, assuming an eight-fold increase in electrical capacity by the year 2000, and half the plants built in that year are nuclear.¹¹

On this basis, accumulated volume of high-level waste can be calculated, assuming 820 gal. waste produced/ton of uranium irradiated, and irradiation levels of 2,000, 4,000, and 10,000 megawatt days/ton.

These volumes are shown in Table III. Changing technology, the developing of alternate techniques of handling these materials, could materially affect future volumes of liquid waste.

At present, radioactive wastes from fuel reprocessing are generated at four locations in the U.S. These are: two plutonium producing plants of the Atomic Energy

Commission — Hanford Atomic Products Operation (General Electric) and the Savannah River Plant (duPont)—and, on a smaller scale at research locations, the Idaho Chemical Processing Plant (Phillips Petroleum) and the Oak Ridge National Laboratory (Union Carbide Nuclear Co.).

In general, waste disposal operations (mainly storage) are similar at each of these locations.

At the Hanford plant, highly radioactive wastes are stored on a semi-permanent basis in 500,000 to 1,000,000 gal. underground tanks. These tanks are constructed of reinforced concrete with mild steel liners.² With vapor headers and condensing systems, they were constructed at a cost of 40¢/gal. of capacity. Based on laboratory corrosion data, estimated life of a 4-in.

Waste Storage at Savannah River: Steel Tank and Cooling Coils

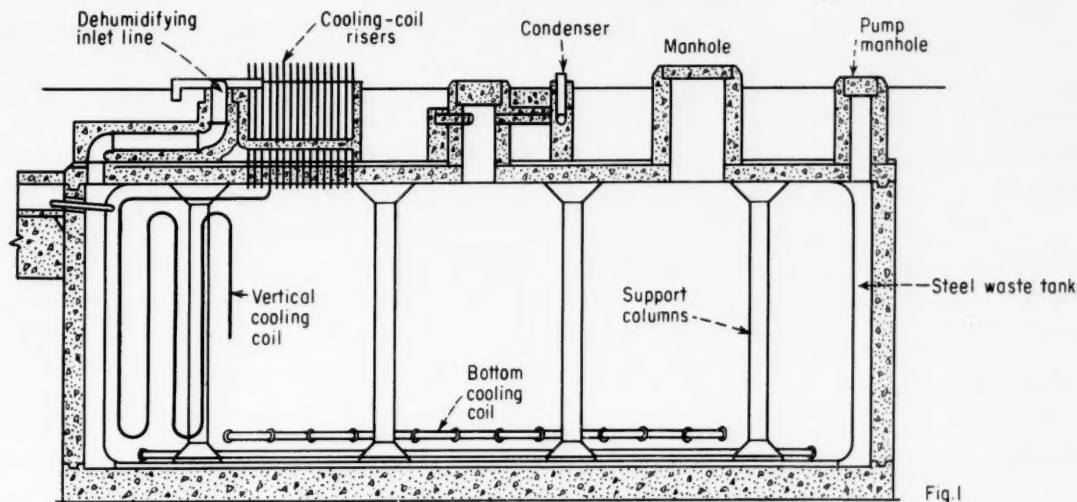


Fig. 1

mild-steel tank liner in contact with boiling waste is in excess of 100 yr. Vapor phase corrosion is faster by a factor³ of 10.

At the Idaho Chemical Processing Plant, high-level radioactive wastes are stored in 300,000 gal. Type 347 stainless-steel storage tanks. These tanks are enclosed in concrete vaults buried under approximately 10 ft. of earth. They contain submerged stainless-steel coils for maintaining waste temperature at 120 F. to minimize corrosion. Tanks are also fitted with reflux condensers.

At Savannah River, high-level wastes are stored in tanks of mild steel encased in concrete with internal cooling coils.^{1, 2}

A schematic of an SRP waste storage tank is shown in Fig. 1. Cup and saucer arrangement is used to insure safe collection of any leakage. Operating temperatures in the tank are held considerably below the boiling point.

Storage of nuclear waste in tanks has a number of limitations including finite capacity, uncertain durability, vulnerability to accidents, and, of course, significant costs. The waste in storage up to Jan. 1, 1957, is shown in Table 1.⁴

AEC Programs R&D

At the present time, the AEC has an active research and development

program with the following objectives:

- Develop better and cheaper ways for safe handling and disposal of gaseous, liquid, and solid wastes—particularly from reactor and chemical processing plant operations.

- Evaluate quantitatively, natural dilution and concentration factors which will fix degree of treatment required before wastes are released to the ground, to the atmosphere or surface areas.

- Learn more about fundamental phenomena and the processes inherent in disposal of radioactive and toxic wastes so more efficient and economical methods may be devised.

- Aid in integrating the nationwide efforts of other Federal agencies, which deal with waste disposal and environmental sanitation problems in industry, with the newer and unique operations in the field of nuclear energy to the mutual advantage of waste-disposal specialists.

- Assist state and local officials, concerned with waste disposal and related environmental problems, in better understanding of related problems in the atomic energy industry.

There is a major objective of research and development activities in disposal of high-level wastes: to

bring to engineering reality ultimate disposal systems which appear technically and economically feasible.

Actual work involves extrapolation of laboratory studies which have already indicated practical disposal systems, such as fixation of radioactive materials and removal of cesium and strontium. And initiation of laboratory and field investigations on ultimate disposal systems shown by preliminary evaluation to be promising. The outstanding priority in this category is disposal into various geological formations.

Three Types of Waste

Liquid nuclear wastes can be classified according to levels of radioactivity as follows:⁵

- **Low Level.** Usually these are large-volume wastes such as drainage from laboratory areas and decontamination operations or water used in basins to shield operators during work on radioactive materials. Usual range of activity is from trace contamination up to 4 microcuries/gal.

- **Intermediate Level.** Intermediate wastes may come from various chemical processes or from relatively large experimental projects. They may contain as much as 10 curies/gal. These wastes must be

Characteristics of Significant Fission Products—Table IV

Isotope	Symbol	Yield %	Half Life		Beta Radiation, Mev.		Gamma Radiation, Mev.	
			Manowitz ^a	GE ^b	Manowitz ^a	GE ^b	Manowitz ^a	GE ^b
Strontium 90.....	Sr	5.3	25 yr.	28 yr.	0.61	0.54	None	None
-Yttrium 90.....	Y		62 hr.	64 hr.	2.3	2.27	None	None
Yttrium 91.....	Y	5.4	57 days	58 days	1.53	1.54	None	1.19
Zirconium 95.....	Zr	6.4	65 days	65 days	0.39 (98%) 1.0 (2%)	0.36 0.39 0.88 ^c	0.73 0.23 0.92 ^c	0.75 0.72
-Niobium 95.....	Nb		35 days	35 days	0.15	0.16	0.76	0.76
Technetium 99.....	Tc	6.2	1 x 10 ⁶ yr.	21 x 10 ⁵ yr.	0.3	0.29	None	None
Ruthenium 106.....	Ru	0.5	1 yr.	1 yr.	0.03	0.04	None	0.51
-Rhodium 106.....	Rh		30 sec.	30 sec.	3.5 (82%) 2.3 (18%)	3.53	0.51 0.73 1.2	0.51 0.62 0.87-2.66
Cesium 137.....	Cs	6.2	33 yr.	30 yr.	0.5 (95%) 1.19 (5%)	0.52 1.18	None	—
-Barium 137.....	Ba		2.6 min.	2.6 min.	None	—	0.66	0.662
Cerium 144.....	Ce	5.3	290 days	285 days	0.35	0.30	None	0.03-0.14
-Praseodymium 144.....	Pr		17.5 min.	17 min.	3.0	2.98 0.8 2.3	0.2 1.2	0.70 2.18 1.48
Promethium 147.....	Pm	2.6	4.4 yr.	2.6 yr.	0.22	0.23	None	None

— Indicates daughter element.

^a Reference 47.^b Chart of the Nuclides, General Electric Co., fifth edition, April 1956.^c Zr has a number of radiation levels.

Current High-Level Solvent Extraction Wastes: Important Properties—Table V

	Purex	Redox	Hexone 25	TBP 25	Thorex
Molar concentration*					
H.....	0.93	-0.3	-0.2	1.33	-0.05
Al.....	—	1.08	1.6	1.63	0.62
Na.....	—	0.23	—	—	—
NH ₄	—	—	1.4	—	—
Hg.....	—	—	0.1	0.01	0.01
NO ₃	0.93	3.05	6.0	6.2	1.8
F.....	—	—	—	—	0.039
Cr ₂ O ₇	—	0.06	—	—	—
NH ₂ SO ₃	—	—	—	0.04	—
Fe, Ni, Cr, g./liter.....	<1	<1	<1	<1	<1
SiO ₂ , g./liter.....	—	—	<1	<1	—
PO ₄ , SO ₄ , g./liter.....	—	—	—	—	<1
Volume untreated.....	990 gal./ton U	1,000 gal./ton U	700 liter/kg. U	670 liter/kg. U	1,360 gal./ton Th
Specific gravity.....	1.03	1.16	1.25	1.25	1.10
Boiling point, °C.....	101	108	105	105	101
Freezing point, °C.....	-3	-18	-24	-24	-15
Specific heat.....	0.97	0.78	0.7	0.7	0.85
Volume after evaporation.....	60 gal./ton U	490 gal./ton U	510 liter/kg. U	500 liter/kg. U	380 gal./ton Th
Volume after neutralization.....	80 gal./ton U	830 gal./ton U	860 liter/kg. U	840 liter/kg. U	640 gal./ton Th

* Chemical composition is exclusive of fission products and heavy elements.

shielded and are often high in dissolved chemical content.

•High Level. High-level or high-activity wastes usually contain quantities of dissolved chemicals and may be highly acid or alkaline. Radioactivity ranges up to 1,300 curies/gal., requiring extensive shielding for personnel and permanent storage.

Disposal of high-level waste presents one of the greatest challenges to chemical engineers.

Characteristics of the more important fission products are shown in Table IV. Note that two elements with the longest half-lives are also the most abundant; cesium-137 and strontium-90.

Table V indicates the characteristics of current high-level wastes (raffinates from solvent extraction separations).⁶ Processes indicated are in current use for processing irradiated fuels. Untreated wastes contain about 1 g./liter of total fission products. The concentration of specific fission products varies with time and for a given fuel is a function of reactor power level during irradiation, length of time the fuel has been irradiated, and the time elapsed since discharge from the reactor. An extensive correlation of such information is available.⁶

Waste radioactivity gradually decreases with time. As the fission products decay giving off beta and gamma radiation, energy of this radiation is transformed into heat by absorption in the surrounding medium. As an example of the heat generated by the decaying fission products, Fig. 2 shows the rate of heat release as a function of time after a fuel element is discharged from a nuclear reactor.⁷ Enrichment was 1.2%; pile power level 5 Mw./ton; irradiation level 2,500 Mwd./ton.

While this figure assumes specific conditions of fuel element composition and irradiation, corresponding curves prepared for any other practical condition of power production would have the same general shape.

Cesium and Strontium

For storage of radioactive wastes, cesium and strontium are the two most important elements. One expert,⁸ suggests for a world nuclear power economy producing 1,000 tons/yr. of fission products, quantitative removal of strontium and cesium from the bulk of the wastes

Fission Products in Irradiated U Produce Heat

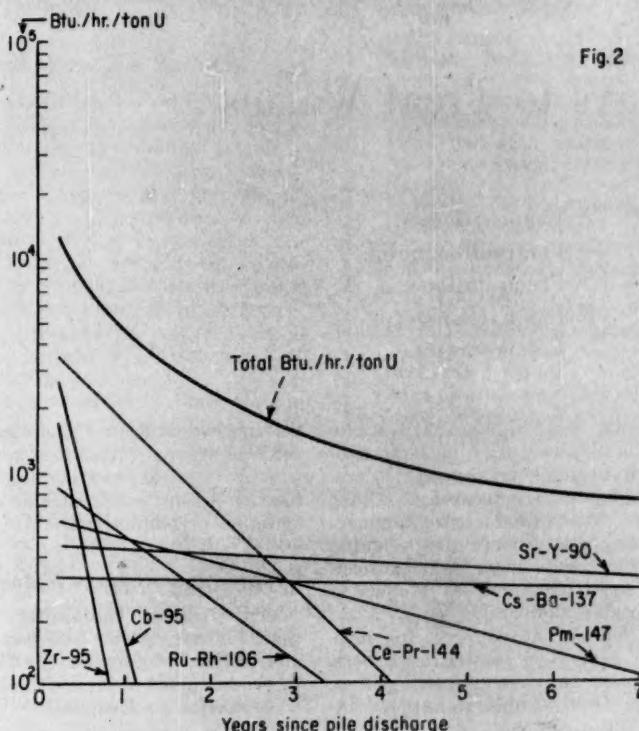


Fig. 2

would permit the remaining bulk to be disposed of by dilution at sea after a 13-yr. storage period.*

Under these conditions the equilibrium contribution of radioactivity to the sea would be less than 1/1,000 that of the natural radioactivity already there. This has been considerably amplified by Rodger⁹ who has calculated effect of varying percentages of strontium-90 left behind in the waste on the required storage period (Table VI).

* This assumes the transuranic isotopes—Pu-239 and 240, Am-241 and Cm-242—are not present. They could make wastes unacceptable for thousands of years after Cs and Sr have decayed to harmless values.

How Sr-90 Affects Length of Storage—Table VI

Sr Remaining, %	Decontamination Factor	Years Storage Required*
0	∞	13
0.00001	10^7	13
0.0001	10^6	90
0.001	10^5	180
0.01	10^4	270
0.1	10^3	360
1.0	10^2	450
10.0	10	540
100.0	1	630

* To point where 1 cubic mile of water will dilute activity to tolerance.

Ways to Treat Wastes

- Evaporation
- Fixation on Solids
- Precipitation
- Ion Exchange
- Calcination

BEFORE any high-activity waste can be disposed of, it must be subjected to some treatment process. Most wastes are treated to either recover fission products for commercial use, or to decontaminate liquids and inert salts from their radioactive constituents, or to produce a disposable radioactive solid.

A number of methods for handling high-level wastes have been proposed and investigated. These range from simple techniques in-

volving evaporation of solutions to removal of longer lived fission products by chemical processes and their fixation within solids such as clays, ceramics or similar materials.^{19, 20}

Evaporation Reduces Volume

With wastes containing more than 10^{-6} curies/liter and less than 10% solids, evaporation is effective in reducing the volume of radioactive material. Evaporated water

can be discharged or recycled as process water.

When the concentrate is stored as liquid, evaporation is carried to roughly 30% solids. At one installation, this concentration is carried to 50% solids. Evaporation costs are in the neighborhood of 4 to 20¢/gal.²¹

At Savannah River, an evaporation test program using a Griscom-Russell Bentube continuous unit with internal heating tubes was set up to reduce wastes to a very concentrated salt solution.²² This would become solid at room temperature.

A study is under way at Hanford to use submerged combustion.²³ Solutions of sodium nitrate and nonradioactive aluminum cladding wastes were concentrated in a 1-million Btu./hr. unit.

Solids Fix Wastes

A number of methods of taking liquid high-level wastes and fixing the radioactive constituents in inert solids have been studied. Important techniques involve use of liquid waste as the liquid in preparing concrete; addition of liquid waste to nepheline syenite to form a nonleachable glass; adsorption and fixation of the important radioactive constituents on montmorillonite clay; retention in ceramic glaze-type fusion; and sintering with natural earth materials.

Cement Can Be Buried

Vitro Corp. of America has studied preparation of dense, homogeneous cement monoliths of radioactive solutions and portland cement. These monoliths are suitable for burial at sea.²⁴

On a laboratory scale, 1 gal. of alkalized liquid waste (900,000 c./m./ml. beta activity) was mixed with 13 to 19 lb. of portland cement. Experiments show that about 5% of this activity could be leached out in sea water.

Actually, cement seems most promising for low- and intermediate-level wastes.

Glass Doesn't Leach

The process under development at Chalk River involves incorporating wastes in a glass using nepheline syenite.^{25, 26, 27, 28, 29, 30, 31, 32} Nepheline syenite melts at about 1,250 C. and when cooled forms a glass.

Adsorb Radioactive Wastes on Montmorillonite Clay Strands



Nepheline syenite is a naturally occurring material, a mixture of nepheline with the two feldspars, albite and microcline. The nepheline in the material reacts with acid to give a silica gel and the mixture solidifies shortly after mixing. Such a gelled mixture can be dried without serious entrainment of particulate matter during removal of volatile materials. A flowsheet is shown in Fig. 3. Rate of leaching of activity from the glass is very low.

Fix on Clay

Much work has been done at Brookhaven on adsorption of fission products on montmorillonite clay.⁴³ Advantages of this system are high capacity and selectivity of the clay as a cation exchanger, relatively low cost, ease of process handling, chemical and physical stability before and after heating, and radiation exposure.

In the process, fission products contact extruded strands of clay and are adsorbed. Exchange capacity of the clay is approximately 1.2 milliequivalents/gram. The clay is then heated to a high temperature (1,000 C.) in either a muffle furnace or by passing the particles through the flame of an oxygen-illuminating gas torch. Clay particles then have a crystallized SiO_2 lattice. Leachability of these clays is very low and is suitable for storage.

Fix in Ceramic Glaze

In this process, developed at MIT,⁴⁴ waste solution mixes with a slurry of lime, borax or boric anhydride and sand. Mixture is evaporated to dryness, heated to 800 C. to insure complete denitration, and then fired. After the glaze matures for about 3 to 24 hr., melt is poured and pellets produced by remelting. Fractional leaching rates in boiling distilled water are low (10^{-4} /sq. cm./week).

Sintering Holds Promise

At ORNL, engineers are working on sintering of waste solutions with natural earth materials.^{19, 44, 45} This process involves mixing a waste solution with limestone, soda ash and locally occurring Conasauga shale. Either self-heating, due to radioactivity of the waste solution, or external heating can sinter the mixture to a solid mass. Qualitative

leaching tests show a minor leaching of cesium.

Precipitation, Ion Exchange

Precipitation is an extremely useful technique for removal of specific fission products from bulk wastes.

It is used, in particular, for removal of cesium and strontium.⁴⁶ This step greatly simplifies further handling of the bulk wastes. In some cases the supernate can be disposed of without further treatment.

There are two techniques for removing cesium. The first uses metal ferrocyanides—which are very specific for cesium—such as ferrous, nickel and cobalt. Ferrocyanide acts as a carrier precipitate, usually at a pH of 7-10. Under optimum conditions radiocesium concentrations have been reduced to 10^{-9} molar in the presence of 5-molar sodium.¹⁹ Decontamination factors are in the order of 300 to 1,000.

A second method for cesium involves co-precipitation with potassium aluminum sulfate or ammonium alum. Results are similar to the ferrocyanide technique.

Radiostromium can be removed by co-precipitation as a phosphate

What About Other Radioactive Wastes?

This report deals primarily with the disposal of high-level radioactive liquid wastes from chemical processing of spent reactor fuels. It's generally conceded that such wastes constitute the major engineering problem.

But keep in mind that intermediate and low-level wastes present acute disposal problems, and there are also gaseous and solid materials.

Gaseous wastes may result from radioactive rare gases produced in air-cooled reactors, or from gases produced in metallurgical processes. Control systems, including high-efficiency filters, are available to handle these situations.

Solid radioactive wastes such as contaminated equipment, scrap and trash don't present any serious problems. Trash is incinerated, equipment buried, other materials sealed in drums and dumped into the sea.

Intermediate and low-level wastes are susceptible to chemical treatments such as evaporation, ion-exchange or precipitation and then burial (see *Chem. Eng.*, Aug. 24, 1959, p. 128).

How Fission Products Can be Fixed on Extruded Pellets

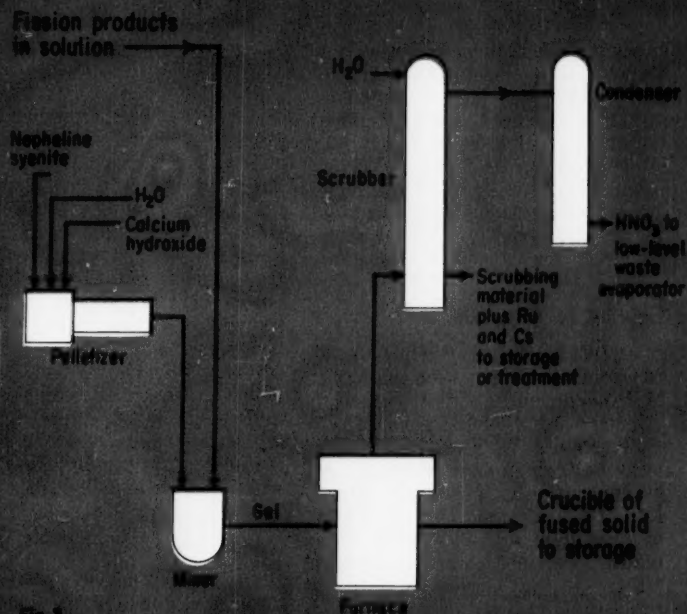


Fig. 3

Fluidized-Bed Calciner Handles High Fission Concentrations

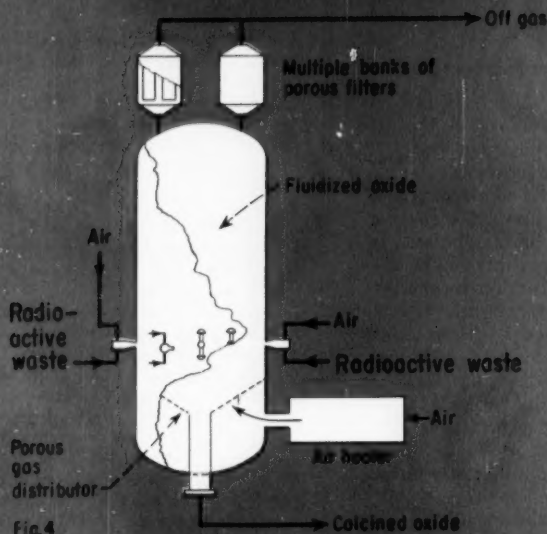


Fig. 4

with calcium or strontium phosphate.^{22, 23} Decontamination factors of 400 are not unusual.

In all cases, precipitates are allowed to settle as a sludge in underground storage tanks. Supernate is then decanted for further treatment or disposal.

Ion-exchange techniques have also been investigated for the treatment of high-level wastes. One disadvantage is possible radiation damage to the resins. However, continuous ion exchangers (particularly the Higgins type) have successfully removed and recovered cesium from alkaline wastes in laboratory demonstrations.²⁷

On a large scale, only precipitation-crystallization has been used to remove strontium and cesium. All other techniques are lab scale.

Calcine in Fluidized Bed

Studies* on the calcination of waste solutions have been conducted at Brookhaven,^{28, 29, 30, 31} Argonne^{31, 32, 33, 34} and at the Idaho Chemical Processing Plant.^{35, 36} These processes involve (1) evaporation of water, (2) decomposition of nitric acid to oxides of nitrogen and (3) conversion of aluminum nitrate to aluminum oxide. Calcined wastes contain

* On nonradioactive synthetic waste solutions.

much higher fission product concentrations than fixed wastes.

By using such techniques, volume

of waste material can be reduced by a large factor, depending upon composition and concentration of the original waste solution. Resulting noncorrosive oxide can be stored in containers fabricated of low-cost metals. Risk of leakage by corrosion is virtually eliminated.

Equipment must be simple and readily adaptable to remote operation before calcination can be carried out safely and economically. Brookhaven has demonstrated use of a screw calciner. At Argonne and Idaho Chemical Processing Plant, a fluidized bed calciner is being developed. Fig. 4 is a pictorial representation of this fluidized bed calciner.³⁵ At Idaho, a pilot plant is being built to be completed by Jan. 31, 1960, to cost about \$6-million.

In addition, BNL workers are studying a rotary-ball-kiln approach to calcination (BNL-535) and ORNL is studying feasibility of a pot calciner for reduction to solids (ORNL-2788).

It should be emphasized that no high-level wastes have been calcined to solids on a pilot-plant scale. All work has been with non radioactive synthetic wastes or at tracer activity levels.

Ultimate Disposal Methods

• Salt Cavities • Deep Wells • Ocean Burial

THERE have been a number of suggestions for ultimate disposal of radioactive wastes.

Among these: burial in dry ground, stagnant ocean deeps, sea canyons in the continental shelf, deep sea muds, permafrost areas near the Arctic Circle, ice caps, caves, rockets to the moon. The first two will be discussed here.

One additional facet to this problem should be pointed out. Oceanographers appear to strongly favor land disposal of these materials while geologists show a decided preference for ocean burial.³⁷ Many experts favor land disposal.

Ocean Burial

On June 22 and 23, 1955, a conference was held at the Woods Hole

Oceanographic Institution on the ocean disposal of radioactive wastes.³⁸ Conclusions were that it's possible to design ocean disposal systems for specific conditions, although there are very difficult equipment and handling problems to be solved.

Disposal of free wastes by dilution would require further studies of mixing patterns in the seas. Studies of the disposal of chemical wastes from barges show it is feasible to get immediate dilution of about 1 part in 10,000.³⁹ Heavily encased wastes may be effectively buried in limited areas of the ocean floor. Currently, small amounts of solid low-level wastes are disposed of in this manner.

The principal problem of ocean disposal is possible reconcentration

of specific fission products in marine life. Radiation levels may be directly damaging to plankton and small marine life. Of course, standards used for drinking water are not applicable here.

And Land Disposal

A conference similar to the one on sea disposal was held at Princeton University to discuss disposal of high-level wastes in geologic structures.^{15, 16}

Two possibilities were included. One was shallow disposal in geologic sites at or close to the surface, in the weathered mantle and in the more readily accessible upper parts of the bedrock within about 1,000 ft. of the surface.

The other was deep disposal in structures reached only by boring as practiced by the petroleum industry at depths between 10,000 and 15,000 ft.

It was the consensus of this conference that several shallow environments might be feasible.

First, salt domes, salt beds, abandoned salt mines and storage in cavities excavated in salt below the surface—but not necessarily near

the base of the local stratigraphic section—were considered very feasible.

For this general type of disposal there are several lines of research:

- Laboratory studies of salt behavior in contact with these liquids under conditions of heat and pressure.

- Heat-transfer characteristics of the salt-bearing structure.

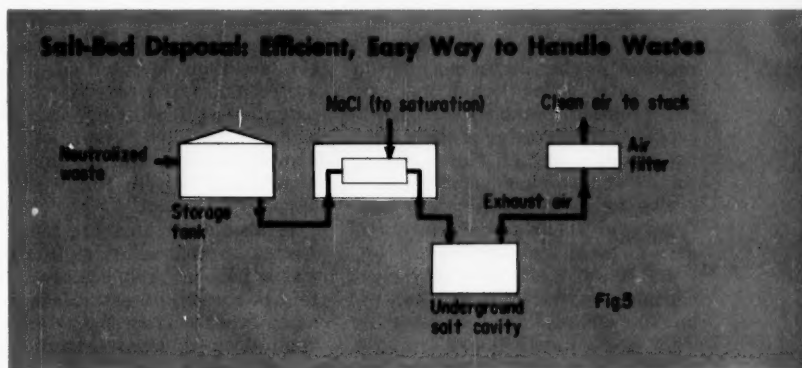
Second in order of feasibility was storage in especially prepared excavations in shale at depth. Relatively thick shale beds are scattered widely over the U.S. Since

shale formations invariably contain many bedding planes, joints, and other porous zones, leakage hazards will have to be considered carefully.

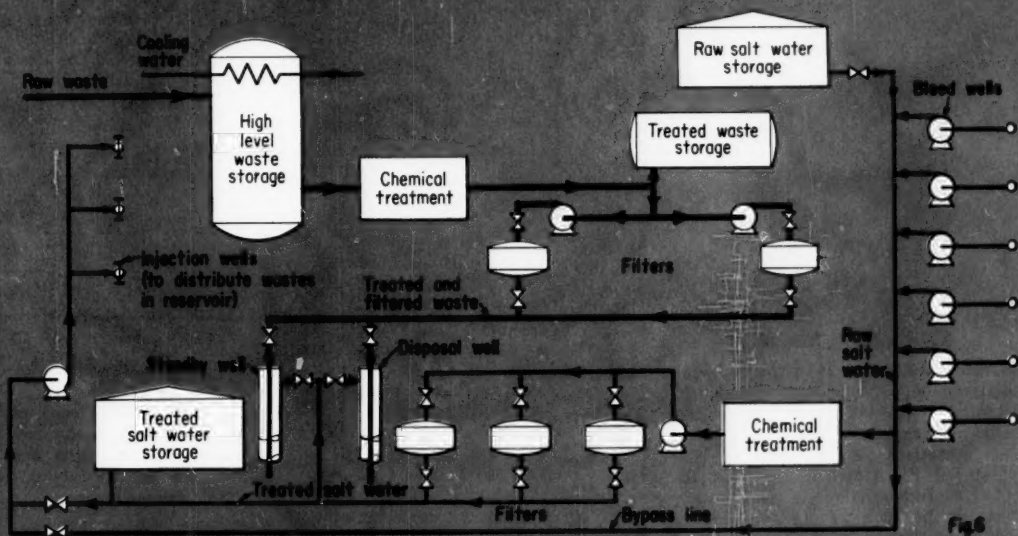
Other possibilities include infiltration into low-permeable beds with a clay content suitable for fixing radioisotopes in place, abandoned dry mines, and shale and clay pits on the surface.

Salt Cavities and Deep Disposal

Disposal of wastes into salt cavities is under study at Oak Ridge.¹⁷ Proposed use of salt formations as



Deep-Well Disposal Involves Injection With Water Into Porous Fields



RADIOACTIVE WASTES . . .

disposal media for these materials is based upon a number of properties such as (1) impermeability to water, (2) wide distribution, (3) large volumes of salt, (4) satisfactory structural properties, (5) high thermal conductivity, (6) lack of seismic activity in salt areas and (7) expected low cost of generating storage volume. Fig. 5 shows a preliminary sketch of a salt disposal facility.

For deep disposal, the Princeton Conference concluded that the volume of waste to be handled would be small for a long time to come as compared with injection of water into oil fields as practiced by the petroleum industry. Disposal, of course, would not be into operating or depleted oil fields, but into deep porous formations.

So this technique has definite promise. Waste solutions must be emplaced so they do not come in contact with living organisms, nor enter zones of potable water, nor be capable of migrating during their dangerous lifetime into potable waters or biologic environments.

The following points were made to serve as guides in the selection of deep-disposal methods:

1. Liquid waste should have a specific gravity greater than the liquids already in the reservoir. This would insure that any migration would be downward and take care of undetected fractures and seismic rupturing of the reservoir stratum.

2. Liquid should be injected underground preferably where it will remain under essentially static conditions.

3. Introduction of fluids into the bottom of structural basins is one means of obtaining the static conditions required.

4. Distribution of waste liquids within the reservoir formation should be monitored by appropriate observation wells.

5. Prior to introduction of nuclear wastes into the reservoir, the problems at heat dissipation, clogging of reservoir pore spaces, and chemical reactions with the rock and fluids would have to be evaluated.

A committee of the American Petroleum Institute has studied the problems involved in deep disposal¹⁸ and has concluded that the major problems of containment in a suitable reservoir, dissipation of heat, protection of the reservoir against plugging or fracturing and corrosion can be solved and a safe well disposal system for certain kinds of waste developed. Fig. 6 shows a hypothetical plant.

It should be obvious, from our discussion, that solutions to nuclear waste disposal problems are important in the attainment of the maximum benefits from the atom. The application of chemical engineering principles and techniques will be instrumental in determining the ultimate solution to this problem.

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When you purchase process equipment . . .

What Guides Buyer-Seller Relations?

A vendor answers some questions:

- Do you have to be a process equipment expert?
- How much should you know about the equipment?
- What decision fixes the course leading to purchase?
- How do you start the ball rolling with the vendor?
- Who (and how many) should receive your bid request?

And buyers comment with some CPI views.

NORMAN H. PARKER, Tower Iron Works Inc., Providence, R. I.

PROBABLY one of the most difficult problems which any chemical engineer faces in the day-to-day performance of his job is specification and purchase of process equipment. Training in chemical engineering has taught us to solve all manner of process and operating problems. But, although it forms a basic part of our everyday life as well as our business life, there has usually been very little time devoted to training in the basic facts and policies of buying.

And, although each one of us makes innumerable daily purchase decisions, there is usually very little correlation between our personal buying habits and the purchase of a piece of major process equipment. We know, of course, that we go through the same steps:

1. Recognizing the need.
2. Selecting the basis of purchase (specification).
3. Evaluation (comparison of bids).
4. The decision.

But, in most respects, that is where the similarity ends.

As we advance in our profession, all of us focus our interest in a particular field of specialization. This may be chemical manufacture, research, process development or design. And even in that specialty, our interest may center on a single area. In some cases, the daily performance of our work includes association with unit operations in which process equipment is in service, and we develop a good working knowledge of some types of equipment. This fact, however, shouldn't obscure the difference between the knowledge of and operation of a piece of equipment and the setting of a specification from which the same piece of equipment must be purchased. It certainly does not answer the question as to how to get the best piece of equipment for the job.

What are the basic factors which enter the picture when we have "recognized the need?" Do we need to be a process equipment specialist? How much do we have to know

about any specific piece of process equipment?

Those of us who are not directly associated with all the process equipment used in various unit operations are fortunate to be able to turn to two sources of information. One is Perry's "Chemical Engineers' Handbook," and the other is the series of major articles on process equipment and unit operations which have appeared in this magazine. These articles are not intended to make us experts, but they do provide a working knowledge of the equipment, the theory of operation, the range of application, and in some cases, include some generalized information which is useful in preliminary cost estimation.

Responsibility Is Key

At this point, we can recognize that there is one basis from which we can approach the problem of how to buy process equipment. This basis will set the course of action which is to follow. This basis is responsibility.

The first decision to be made is to determine on whom the final responsibility will rest for the operation and performance of the equipment. This should be done whether a specification is being developed

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Address _____

Information given by Mr. _____ Title _____

1. Service _____

2. Type _____

3. Quantity of Feed Liquid to be evaporated per hour _____

4. Density of Feed Liquid _____, Of Final Product _____

5. Name and chemical composition _____

a) Feed Liquid

b) Final Product

6. Temperature of Feed Liquid _____ °F

7. Boiling point of Feed Liquid _____ °F at _____ mm Hg Abs.

of Final Product _____ °F at _____ mm Hg Abs.

(If possible give intermediate boiling points with the pressure for each concentration)

8. Specific Heat of Feed Liquid _____, Of Final Product _____

9. Heat of vaporization _____

(Chart for enthalpy vs. concentration at different temperatures if available)

10. Viscosity of Feed Liquid _____ at _____ °F

of Final Product _____ at _____ °F

(Chart for viscosity vs. concentration at different temperatures if available)

11. Maximum allowable temperature during evaporation _____ °F

12. Maximum allowable exposure time to air _____

13. Liquid characteristics

a) Foaming _____ g) Explosive _____

b) Scaling _____ h) Solids Separated: _____

c) Corrosive _____ Nature _____

d) pH-Value _____ Lbs/Hr. _____

e) Flash Point _____ Desired Purity _____

f) Toxicity _____ i) Others _____

14. Live steam available, Pressure _____ psig. Quantity _____, Cost per M Lbs _____

15. Exhaust steam available, Pressure _____ psig. Quantity _____, Cost per M Lbs _____

16. Cooling water available, GPM _____, Source _____

Temp. Min. _____ °F, Max. _____ °F, Cost per M Gals _____

17. Current characteristics, AC or DC _____, Phase _____

18. Materials of construction preferred _____

for a budget estimate or for equipment purchase. The question is:

(a) Do you (your company) want the responsibility for the mechanical and process design;

(b) Do you want the equipment vendor to accept complete responsibility for design and performance?

The answer will determine the type of vendors to whom your inquiry should be addressed.

There is, of course, an area between these two alternatives. Many of us, in our field of interest, have developed areas of specialization in process design on which we and our company are entitled to capitalize. In the case where our experience is such that we can perform the functional design of a piece of equipment, it would be wise to divide the responsibility. We could accept process and performance responsibility, passing to a vendor the responsibility for mechanical design only.

OIL COMPANY says . . .

"Responsibility for an engineered item of process equipment must be borne jointly by purchaser and vendor. Although the vendor is solely responsible for mechanical performance of his equipment, the purchaser must assume responsibility for application of the equipment, range of operating conditions—pressure, temperature and capacity swings."

Let us examine how these two basic alternates affect the type of vendor selected.

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GENERAL

Please fill in as completely as possible each requested information as applies to your particular product.

1. TYPE OF MIXING OPERATION

a. Batch () or continuous ()

b. Liquid level variation.

c. Operative to be accomplished

2. MATERIALS TO BE MIXED

a. Liquids

Specific Gravity

Viscosity

Feed rate or volume

Temperature

Maximum viscosity of mixture

b. Solids

Specific Gravity

Moisture

When the purchaser takes complete responsibility for the equipment design and performance, there is certainly no need to have any equipment vendor repeat the design steps. This is uneconomical as well, since it represents duplicate engineering which is added to the cost of the equipment. It is logical, therefore, to send complete design drawings and specifications to a specialty fabricator to quote on manufacture only. The major problem here is usually encountered in those companies which do not have sufficient depth in the engineering staff to handle the mechanical features of the equipment design after the functional engineering has been completed.

The alternative is to put the entire responsibility in the hands of the equipment vendor. This is what the major equipment vendors prefer, and this is the type of job they are geared to do. Their engineering staffs are composed of specialists who have immediate access to all the knowledge and experience gained during the span of the company's operation. It could be said that the major equipment vendors serve as consulting engineers in their field of specialization. They stand ready to place at the disposal of their customers their knowledge and experience, and provide a piece of equipment whose performance they will stand behind.

CONSULTANT says . . .

"Engineering, for greatest effectiveness, cannot be combined with equipment sale. The engineering, if properly done, results in smaller sales of equipment. It's asking a great deal to expect equipment vendors to spend their money to reduce their volumes or to make their proprietary equipment obsolete. In such industries as coal, steel, etc., where vendor engineering is the rule, basic product improvements are rare and plant costs are extremely high."

The decision as to which way to go on "responsibility" can usually be answered in terms of a specific job. There will always be those companies whose central engineering staff is fully equipped and com-

petent to handle the design of process equipment. And there will always be those companies whose engineering departments are devoted wholly to process and operations. And as always, there are those whose departments contain experienced personnel who are specialists in their company's field of operations.

CHEMICAL COMPANY

says . . .

"On a rather standard piece of equipment like a pump, almost any purchaser—whether sophisticated engineer or quite dependent on suppliers' judgment—is inclined to specify performance required in gpm. and differential pressure. He knows from the standard design of the suppliers he solicits exactly what type of pump he is obtaining. On the other hand, if he were buying a cracking furnace, he may have to be quite specific about diameter of tubes, residence time, temperatures to be attained; he leaves entire discretion for type and number of burners to go in the furnace walls to the reputable vendor. Of course, engineering maturity helps fix the "right way."

There are no hard and fast rules which will determine which way to go. There may be a company policy which favors the internal engineering of equipment to retain company "know-how" or process art or experience. On the other hand, entrance into a new field of process operation may dictate calling on the specialization and experience of equipment vendors for proper specification and selection of equipment.

CONSULTANT says . . .

"The vendor's engineer is basically the agent of vendor's sales department. There is engineering talent from several vendors involved in any major sale. Inevitably a buyer must confine the discussion with vendor's sales engineers to an area as limited as practical and avoid unnecessary disclosure of material vital to the buyer's

business. It is practical, and in the buyer's best interest to take an independent consultant into confidence. In addition to augmenting the buyer's staff for the temporary engineering need, the consultant's position encourages trust. It is difficult to visualize such a relationship with all vendors' engineers who might be competing for the specific job."

However, any company jealous of its reputation for integrity and fair dealing will want you to make a decision one way or the other. And once the decision is made, don't change horses in midstream. As in everyday living, there are ethics involved in dealing with equipment vendors, too.

Pathway of Buying

After the decision has been made, start the ball rolling with the vendors. Of course, either the specialty fabricator or the equipment vendor is going to want to know what you want him to do.

Let's take the case of the specialty fabricator first. After you have decided to purchase a piece of process equipment, you will have completed the functional design, and sent it to mechanical engineering for detailed design (or done it yourself). Then is time enough to call the specialty fabricators on your approved list to give them the drawings and specifications. (We are assuming here that any company protocol with regard to the functions of your purchasing department have automatically been complied with.) Your specialty fabricator, like the prospective builder of your house, will review your plans and specifications, and bring to you any questions. When the questions have been resolved, he can prepare a quotation.

Actually, it would not be unfair to state at this point that few specialty fabricators maintain anything beyond the simplest engineering department. The overhead which it represents is usually considered put to better use in sales effort. This is the limiting factor in how much responsibility for mechanical design can be transferred. Those specialty fabricators who maintain departments capable

of equipment design cannot provide this service gratis, and the cost to the customer on a hybrid job where the customer furnishes the functional design and the fabricator the mechanical engineering is always higher than the cost of fabricating alone.

Give Enough Data

When the decision has been made to use the services of a major equipment vendor, the prime concern is to get the information together in a form which will permit the vendor to review and select the data he considers pertinent, and request additional information, if required. Over the years each vendor has developed a form, or outline, for process data which presents it in what he considers the most satisfactory manner. Although these "data sheets" may vary somewhat in detail from company to company, a brief review will show they all have the same basic requirements. Several typical data sheets are presented on the previous page to show the information required.

If you have dealt with any of the major equipment vendors, you may be sufficiently familiar with what the data sheets contain for some pieces of process equipment to write a specification outlining the process problem. One well-known company uses a simple method of soliciting vendors' assistance in tying down the data required on new problem. They send a brief description of what they plan to do, with any available data, to their approved list of vendors. The vendors who have something to contribute to the solution of the problem will come in to clarify questionable areas, to request laboratory tests or to get additional information to solve the problem.

The company's experience with standard problems on various types of process equipment, however, has reached the point that they can completely outline any "usual" application. In the above example, the response to the general inquiry also serves as a guide to those vendors who are interested in the problem presented and who will be queried again on similar problems. This is an added bonus, in a standard procedure, for the purchaser.

In the buyers' market which exists today, this probably represents

the best approach. In sending out a general inquiry, specify the type of problem (e.g., drying, evaporation, de-watering, etc.), the initial and final conditions and the throughput required. In addition, outline the material characteristics, and indicate that further discussion of the problem with the vendor's engineers would be welcomed.

How Many Requests?

The next logical question would be how many prospective vendors should a bid request be sent to. Of course, your purchasing department may have policies which require a minimum of three vendors on any bid request where a certain dollar value is to be exceeded. On the other hand, upon checking such standard reference sources as "Sweet's Catalog" or "Chemical Engineering Catalog," we can find as many as twenty companies listed under some product headings.

But for one factor, this would present a difficult problem in evaluation of itself. However, most of us at one time or another have had at least brief exposures to such excellent series as those which have appeared in *Chemical Engineering* on equipment. They provide us with a working knowledge of various pieces of equipment; they can also provide a guide to the leaders among the major equipment vendors. With these as a guide, the other lists of vendors can be culled for additional prospective suppliers.

Actually, the number of vendors should be kept to the minimum acceptable to your purchasing policy. As the purchaser, you want only those vendors who enjoy the highest reputation in their respective fields. In addition, while the vendor is interested in every prospective job and will bend every effort to promptly and properly supply any prospective purchaser with requested and required information, he does not relish the expenditure of time and effort where he is one among many. Furthermore, the evaluation is complicated considerably as the number of bids increases.

We have been talking up to this point in terms of getting firm estimates. However, the same general principles apply to budget estimates. It is important to add one word of caution here. It is better

to send out several inquiries for budget estimates than to confine your budget figure requests to one vendor, although this latter procedure seems to be the simplest and most economical. Although all vendors encourage it, a "favored-vendor" situation can develop as a result of using a single vendor for all preliminary or budget information.

CONSULTANT says . . .

"An engineer responsible to a client is obliged to remain neutral among vendors. He cannot allow a "favored vendor" situation to arise. His sole obligation is to his client."

We might summarize the main point before passing to others: The basic decision to be made in any vendor-buyer relation is that of responsibility—do you want to accept total responsibility, and if not, how do you want to divide responsibility? The answer to this largely determines your vendor(s). From then on, proper flow of information culminates in bid requests. In the next installment, we will examine more closely what goes into the buyer-seller ethical relation.

COMING NEXT:

In Part II of this three-part series, Mr. Parker will present the vendor's view on ethics in dealing with the vendor in buying process equipment. Among other things, he will show what vendors need to know to give you the best design for lowest first cost, how much pre-purchase engineering you should expect from the vendor, and what the vendor expects of you. As in the article in this issue, we will solicit opinion from engineers in the chemical process industries. These comments, interspersed in appropriate places in the text of Mr. Parker's article, may help stimulate your thinking in your own work.



Liquefaction: New Gas Market

New plant produces liquid methane at -259°F. in tanker quantities for shipment by sea to distant locations.

JAMES DE LURY, Manager, Process and Research Dept., J. F. Pritchard & Co., Kansas City, Mo.

VENEZUELA, North Africa, the Middle East and Pakistan have supplies of natural gas which far exceed their needs. Western Europe, South Africa, Australia and Japan must depend on manufactured gas produced locally. These have-not nations are a potentially great market for the producing nations—if the gas is available at a competitive price.

Gas cannot be sent from Iraq to England, from Pakistan to Japan by pipeline. The costs of building and operating such a pipeline would price the gas out of the market. To compete successfully with the local product, gas must move in bulk, in ships.

The only economical way to move a gas in bulk is as a liquid. Natural gases consisting primarily of butane and propane present no great problem in this regard since they can be liquefied at pressures below 200 psi. at temperatures up to 100°F. The cost of storage and transportation facilities for handling gas at these pressures is not prohibitive. The smaller liquid volume offsets the increased cost of the pressure vessels.

Methane-based gases cannot be liquefied at normal temperatures. The critical temperature lies below -100°F. ; the critical pressure is about 800 psi. Bulk transportation and storage of methane as a gas is not economical because the pressures required for a significant reduction in volume are too high. However, methane can be liquefied (at very low temperatures) and moved by ship to the point of use where it can be competitive with locally manufactured gas. One cubic foot of methane liquid, at -260°F. , is equivalent to 630 SCF. of methane gas.

There are other advantages to liquefaction of natural gas, even where there are pipelines, as in the northeastern United States. Liquefaction permits large volume tank storage close to major markets where geology does not allow underground storage. Surplus pipeline gas may be liquefied during summer months, stored and re-vaporized during the winter when fuel demand is in excess of pipeline deliveries. In addition to improving the pipeline load factor, it enables the distributor to sell more

gas at a higher rate on a non-interruptible basis.

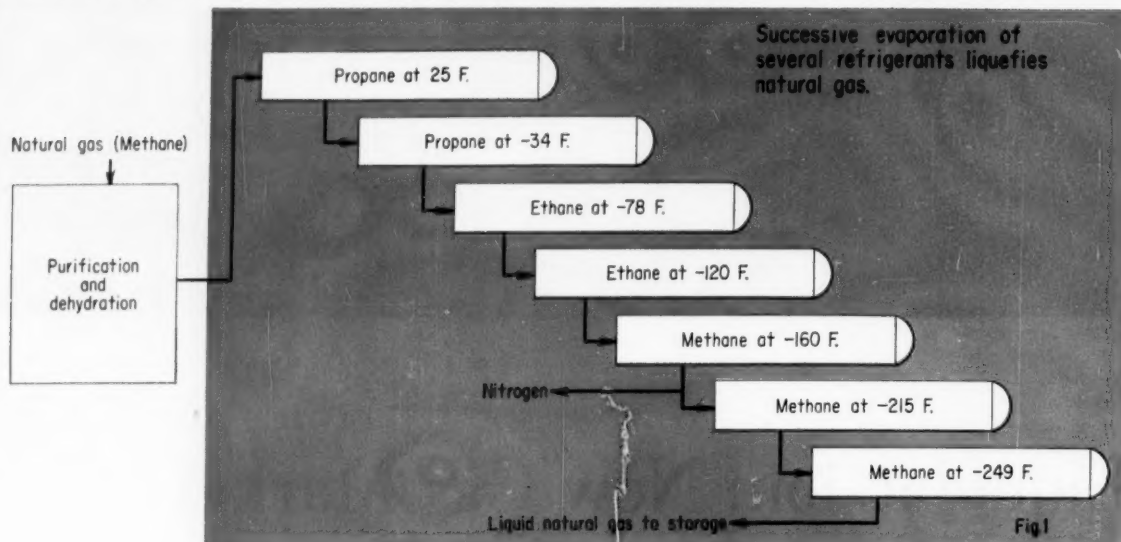
Two recent papers^{1,2} discussed the economics of liquid methane for peak shaving.

Composition of Natural Gas

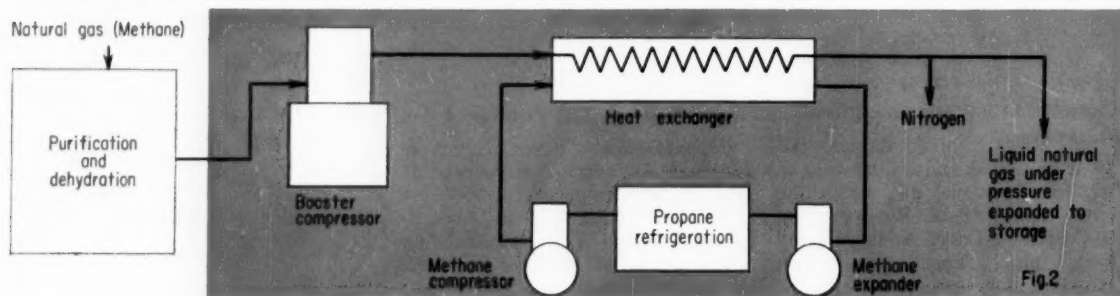
Natural gases vary widely in composition but usually consist principally of paraffinic hydrocarbons with varying quantities of naphthenes and aromatics, nitrogen, helium, carbon dioxide, hydrogen sulfide and water vapor. Gas is produced from dry gas and condensate fields or incidental to crude oil production. It may be available at high or low pressure.

The vapor pressure curve for methane shows that storage of methane liquid at atmospheric pressure requires an operating temperature of -259°F. The bubble point curve for a typical pipeline gas containing 95 to 98% methane shows that operating conditions are very close to those for pure methane. This is typical of a stripped gas which might be used for peak shaving by a domestic gas distributor. An unstripped gas con-

Cascade Cycle Requires More Equipment but Uses Less Power



Expansion Cycle Is Simple, Suitable for Small Installations



taining only 72% methane would have a bubble point of -250°F . at atmospheric pressure, typical of a gas which might be available at an overseas location.

To make a natural gas merchantable or suitable as a feedstock for a liquefaction unit, one must remove carbon dioxide, hydrogen sulfide and water vapor. Treatment with amine and hot carbonate solutions and drying by contact with solid dessicants will remove acid gases. These processes are well described in the literature and will not be considered further at this time.

Phase equilibria data² on the methane-carbon dioxide system indicate that quantitative removal of

the carbon dioxide from the feed gas may not be necessary. However, we need to do further experimental work to establish the permissible limits of carbon dioxide in gas for liquefaction.

Two Ways to Liquefy

Before one can design a gas liquefaction unit, the refrigeration cycle to be used must be established. Choice of cycle is dependent on several factors, including the capacity of the unit and weight and space limitations. Shore-based or shipboard installation will also influence the choice. We will confine this article to a discussion of two cycles: cascade and expander.

The cascade cycle diagrammed in Fig. 1 uses several refrigerants in series, each used over that temperature range in which it is most efficient. For example, water or air condenses propane; propane, in turn, cools natural gas to about -34°F . and also condenses ethane refrigerant. The ethane cools and condenses the natural gas to -116°F . and condenses methane refrigerant. Methane refrigerant can then chill the liquid gas to the storage temperature, approximately -250°F .

The cascade cycle can use other combinations of refrigerants than those shown in Fig. 1. For example, the East Ohio plant operated on water, ammonia, ethylene and

methane. The Chicago District Pipeline plant would have used water, propane, ethylene, methane and nitrogen. A major consideration in the choice of refrigerants, aside from efficiency, is ease of replacement should a charge be lost. At some foreign locations it would be advisable to use refrigerants which could be derived from the feedstock itself.

In the expander cycle (see Fig. 2) the natural gas is liquefied by heat exchange under pressure with methane refrigerant. An ammonia or propane refrigeration cycle cools the pressurized (about 1,500 psi.) methane refrigerant. The methane, in turn, expands isentropically in an expansion engine and exhausts from the engine as saturated vapor at -250°F . The cold methane then cools the natural gas feedstock, also at 1,500 psi., below its critical temperature. The liquefied natural gas is further cooled to its final temperature by allowing it to flash into the storage tank at atmospheric pressure.

It is fairly obvious from the description above that the cascade cycle requires a rather complex plant. However, a series of refrigerants used in the manner described improves the reversibility of the process and makes it more efficient, thermodynamically, than the expander cycle. Liquefaction of 1,000,000 SCF./D. of stripped natural gas received at 700 psig. requires about 460 brake hp. in a well designed cascade unit. About 90% of the sweet gas charged to the unit is liquefied, the remaining 10% going to fuel for steam boilers, compressors, electric generators, etc.

The expander cycle, on the other hand, permits design of a relatively simple plant, one with fewer items of equipment. However, a well designed expander plant requires 830 brake hp. compared with the 460 bhp. consumed by the cascade cycle. The expansion engine would develop 100 bhp. for a net requirement of 730 bhp. Only 80% of the sweet gas charged to the plant would be liquefied, the remainder going to fuel.

Where fuel is cheap, a relatively inefficient cycle would appear justified. But horsepower requirements increase as the efficiency of the process decreases. Consequently, capital investment charges also increase with increasing ineffi-

Short History of Natural Gas Liquefaction Plants

Natural gas has been liquefied since the early days of helium production. Hope Natural Gas of West Virginia liquefied natural gas on a pilot scale in 1940. Their plant liquefied 300,000 cu. ft./day and had storage for about 14,500 gal. of liquefied gas, an equivalent of 1,000,000 standard cubic feet. The unit served as the design basis for the larger plant of the East Ohio Gas Co. that was built in 1941.

The East Ohio plant liquefied 4,000,000 SCF./D. with ultimate storage for 250,000,000 SCF. This plant operated very satisfactorily until rupture of one of the storage tanks in October, 1944, destroyed the entire installation with large loss of life and property. The investigation which followed established that the design and operation of the plant were sound; the cause of the accident was probably a fault in the tank metallurgy. The investigation also established, somewhat belatedly, that the plant should not have been built in a congested area.

In 1949, the Chicago District Pipeline Co. proposed the construction of a gas liquefaction plant.

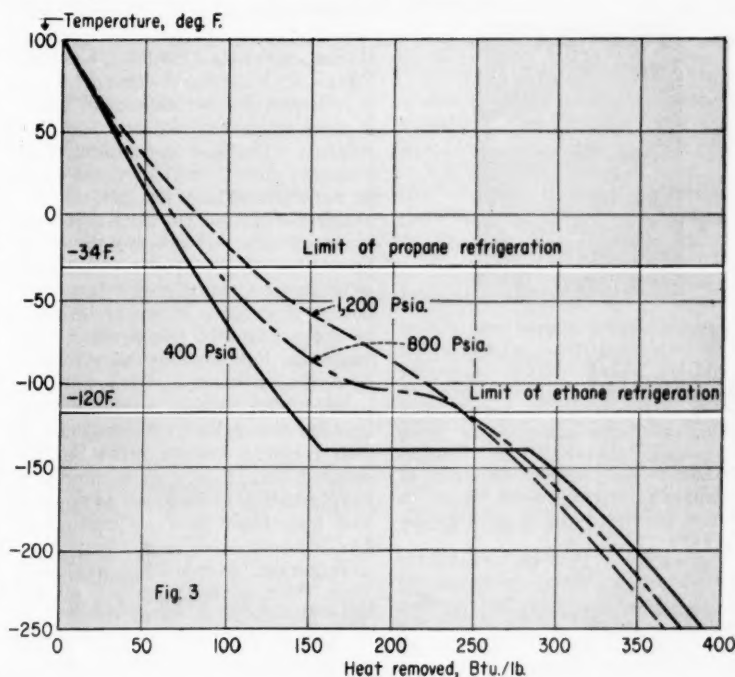
The project was abandoned, however, when suitable underground storage became available.

A plant similar to the East Ohio unit but designed to liquefy 4,500,000 SCF./D. was turned over to the Russians in 1947 under Lend-Lease. This plant is operating satisfactorily today.

Another natural gas liquefaction unit which is currently in service is the experimental barge mounted unit of Constock International Methane, Ltd. This plant will liquefy between 6 and 8,000,000 SCF./D. and has been in operation since 1956. Recently it has provided cargoes for the "Methane Pioneer", a converted C-1 dry cargo ship owned jointly by the British Gas Council and Constock. The photograph is of "Methane Pioneer," shown here while loading liquid methane from shore-based storage tanks.

Constock International Methane, Ltd., is a joint venture of the Continental Oil Co. and the Union Stock Yards and Transit Co. of Chicago. Constock intends to liquefy large volumes of natural gas and ship it by tanker to overseas areas.

Cooling Curves Show Effect of Pressure



ciency. Therefore, for a large unit, the most efficient cycle, the cascade cycle, is the cheapest one. For small units, though, the expander cycle is actually the cheaper because of the lower capital investment.

The cascade cycle is obviously best for a fixed primary liquefaction plant. The expander cycle lends itself to small or mobile installations, such as a shipboard recondensation unit.

A cooling curve chart (Fig. 3) shows how much heat must be removed from a pound of methane at 100 F. to convert it to liquid at -250 F. The chart also shows the temperature level at which the heat must be removed. Design limit temperature levels of propane and ethane refrigeration are -34 F. and -120 F. respectively. These limits were chosen to preclude pulling a vacuum at the refrigerant compressor.

Pressure of the feed gas is an important factor in the design of the liquefaction unit. Methane gas at 400 psia. requires methane refrigeration at -145 F. to remove latent heat. Refrigeration at this level is expensive, requiring some 7.25 bhp. per ton of refrigeration. If the pressure of the feed gas is raised to 800 psia., above the criti-

cal pressure for methane, the cooling curve no longer passes through a two-phase region. One can now remove the equivalent of latent heat within the limits of ethane refrigeration and correspondingly reduce horsepower requirements. If the gas pressure is raised to 1,200 psia., refrigeration horsepower is further reduced since additional heat may be removed with propane and high level ethane.

Development of a cooling curve for a given natural gas requires calculation of the dew-point, the bubble point, and the quantity and composition of the vapor and liquid present at various temperatures. A consistent set of vapor-liquid equilibrium ratios, such as those published by the Natural Gasoline Association of America⁴ or DePriester⁵, is needed to perform these calculations.

With phase compositions and quantities determined, one must then calculate how much heat to remove from the inlet gas. This requires selection of the proper enthalpy data.

A natural gas may consist of many components with differing properties. Some components will be in the vapor phase when their properties as a pure material indicate they should be liquid. Other components will be in the liquid phase at temperatures above their critical temperatures. Clearly, one should employ partial enthalpies to obtain accurate results. Canjar, Edmister, Peters and others⁶⁻⁸ have done a considerable amount of work in developing correlations for calculating partial enthalpies for hydrocarbons. However, these data do not agree. There are not, as yet, enough experimental data to check their accuracy. Further, there is no set of correlations consistent with accepted equilibrium data that covers the entire range of interest in the gas liquefaction process. One must use judgment in the selection of enthalpy values.

When the cooling curve for the gas is determined, the associated refrigeration system must be calculated. Or, if only an estimate of refrigeration horsepower is needed, one may refer to a correlation of brake horsepower as a function of refrigerant evaporating temperature. Such correlations are available.^{4, 10}

Higher molecular weight fractions of natural gas frequently con-

tain components, such as aromatics, which become insoluble in the main body of the liquid when cooled to around -200 F. To minimize operational difficulties from this source, liquids should be drained from the system at an early stage of the liquefaction process when these materials first condense.

Liquid Storage

Liquid gas is stored at atmospheric pressure in cylindrical tanks. These tanks are of flat bottom, double wall, umbrella roof construction. There is 3 ft. of granular perlite insulation between the vertical walls. The inner tank is aluminum, the outer stainless steel. So that it will not creep in the course of repeated heating and cooling cycles, the inner tank is anchored or keyed to the concrete floor. To prevent the earth under the tank from freezing and heaving, the foundation is equipped with a heating coil or is elevated on pilings. Constock's tank at Lake Charles, La., is 67 ft. in diameter and 56 ft. high. It has a capacity of about 35,000 bbl. of liquid gas, equivalent to 100,000,000 SCF. of gas. Insulation of the tank is so effective, daily losses from heat leakage are only 0.2% of the volume when full.

The future of the liquid natural gas industry promises to be bright. Already "Methane Pioneer" has carried several loads of liquid gas from Louisiana to England. These trial trips proved that the gas could be liquefied and shipped at less cost than gas manufactured locally. The next step is more ships, but regular commercial shipments are another 2½ years off yet.

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This article is based on a paper presented at the 1959 Cryogenic Engineering Conference, Berkeley, Calif., in Sept. 1959.



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For these quantities, how to . . .

Estimate Engineering Properties

- Refractive index
- Polarity and normality
- Quick parachor calculation
- Liquid phase expansion and compressibility
- Heat capacity
- Diffusion coefficients
- Thermal conductivity: gases
- Thermal conductivity: liquids

WALLACE R. GAMBILL, Union Carbide Nuclear Co., Oak Ridge, Tenn.

IN THIS next-to-the-last installment, we'll take up some miscellaneous property areas not previously covered. Then, we'll backtrack a bit to include some good estimation methods for the properties already covered. These estimation methods were either missed the first time around or have since appeared in the literature.

Refractive Index

Refractive indexes may be roughly estimated by the Lorentz-Lorenz expression:

$$[R_D] = \frac{M}{\rho_L} \left(\frac{n_D^2 - 1}{n_D^2 + 2} \right) \quad (1)$$

Solving for n yields:

$$n = \left(\frac{2[R_D] + V}{V - [R_D]} \right)^{0.5} \quad (2)$$

Alternatively, use may be made of the Landee-Whittier approximation¹ which may be cast into the following form:

$$n = 1 + \frac{0.3218 \rho_L^{0.88} T_b^{0.12}}{N^{0.08}} \quad (3)$$

where ρ_L is liquid density at 20 C., grams/ml.; T_b is normal boiling

point, °K. and N is number of atoms per molecule.

While Eq. (2) applies generally, Eq. (3) is for branched alkanes at

20 C. only. Eq. (3) shows excellent correlation for 151 alkanes for which $1.35 < n < 1.46$.

For hydrocarbons only, Ward and Kurtz have proposed the following simple empirical approximation:

$$\Delta n = 0.6 \Delta \rho_L \quad (4)$$

where Δn and $\Delta \rho_L$ are corresponding changes in refractive index and liquid density.

Kurtz and others,² showed that Eq. (4) agreed with considerable data with an average deviation of $\pm 8 \times 10^{-4}/^\circ\text{C}$.

Sonic Velocity in Liquids

For an available summary of prediction methods for sonic velocity in liquids, see Ref. 4. A more recent method for liquid mixtures may be found in Ref. 5. We have already treated Rao's method³, which is one of the simplest and most accurate.

Polarity and Normality

We have made many reference to polar liquids in describing the restrictions associated with some estimation methods. Generally speaking, a polar liquid is one whose

Coming Soon . . .

Our next article which will appear in an early issue concludes this three-year series on "How to Estimate Engineering Properties." In the final article, W. R. Gambill will demonstrate the applicability of the estimation methods covered in this series to one or more chemicals.

Previous parts of this series are now available in reprint form. For fastest service, please use Reader Service postcards. See p. 231 for prices and order by number.

Thermal Conductivity.....	94
Heat Capacity	109
Latent Heat	117
Surface Tension.....	126
Viscosity	138
Pressure, Volume and Temperature	149

molecules possess permanent dipoles.

More specifically, the various compound classes have been ranked⁷ in order of increasing polarity as follows: esters, oxides, aldehydes, ketones, acetals and alcohols. Within a given group, olefinic and straight chain molecules are more polar than are paraffinic and branched chain molecules, respectively. Similarly, compounds of lower molecular weight exhibit greater polarity.

Magnitudes of dielectric constants can also give an idea of relative polarities. Still more specifically, Curl and Pitzer⁸ have proposed an equation which supposedly characterizes normal liquids with good precision.

Quick Parachor Calculation

Earlier in this series,⁹ we gave a table of the standard contributions for both molar refraction and parachor. McGowan¹⁰ has proposed a

somewhat more rapid method which dispenses with strain constants. This method is based on the additive atomic contributions of Table I and subtraction of 19 for every bond whether single, double or triple. The method appears to work well, giving an average deviation of 1.6% for 36 compounds (organic and inorganic).

Liquid-Phase Expansion

Thermal coefficient of volumetric expansion is defined by:

$$\beta = \frac{1}{V} \left(\frac{\partial V}{\partial T} \right)_P \quad (5)$$

If sufficiently accurate density data are available, it may be closely approximated from:

$$\beta = \frac{(1/\rho_2) - (1/\rho_1)}{(t_2 - t_1)(1/\rho_{avg})} \quad (6)$$

Of course, Eq. (6) is merely a finite difference form of Eq. (5). It is desirable to select the temperatures as close to each other as is consistent with the accuracy of the density data since the calculated value of β corresponds to the temperature halfway between t_1 and t_2 . Eq. (6) may also be written in the following form:

$$\beta = \frac{s_1^2 - s_2^2}{2(t_2 - t_1)s_1s_2} \quad (7)$$

where s is specific gravity.

Smith and others¹¹ have shown that β may be estimated to within about 5% for a large variety of organic compounds from the following equation.

$$\beta = 0.04314/(T_c - T)^{0.441} \quad (8)$$

where $\beta = 1/^\circ\text{K.}$ and $T_c = ^\circ\text{K.}$

Polar liquids deviate the most from Eq. (8), which might prove useful in the absence of good density data. A somewhat simpler but less accurate rule was later advanced by Duggar:¹²

$$\beta = 0.3/(T_c - T) \quad (9)$$

This equation which supposedly applies only to normal liquids was tested by the author with β data at 20 C. only for 13 liquids. The average and maximum deviations were 13.4% and 45% respectively.

Both Tsien¹³ and Wall and Krigbaum¹⁴ have proposed simple generalized rules for the estimation of β and the isothermal compressibility α which is defined by:

$$\alpha = -\frac{1}{V} \left(\frac{\partial V}{\partial P} \right)_T \quad (10)$$

The methods of Ref. 14 are both simpler and more accurate and are summarized in Table II. Wada¹⁵ proposed a method based on additive contributions by which adiabatic as well as isothermal compressibilities may be estimated.

We will now take up additional methods for the physical properties covered in the earlier articles of this series.

Heat Capacity Methods

For organic liquids, a modified Kopp's rule, utilizing additive contribution constants, has been suggested by Johnson and Huang.¹⁶ The contributions of Table III are simply added to obtain the molar heat capacity at 20 C. in cal./ (gram-mole) ($^\circ\text{C.}$).

In the original article,¹⁶ an average deviation of 5% was claimed for 84 organics. The author's tests with data for 52 organic liquids gave average and maximum errors of 4.9% and 13.6% respectively. The method appears poor only for aldehydes and the first members of homologous series. Table III may be combined with the Chow-Bright temperature function [*Chem. Eng.*, July 1957, p. 267] to obtain C_p at any temperature.

Sharp and Ginther¹⁷ present an empirical equation for the effect of temperature and composition on the specific heat of glass which appears

Nomenclature

<i>a</i>	Constant.
<i>b</i>	Constant.
<i>D</i> ₁₂	Binary gaseous diffusion coefficient.
<i>f</i>	Constant.
<i>k</i>	Thermal conductivity.
<i>L</i> _v	Latent heat of vaporization.
<i>M</i>	Molecular weight.
<i>n</i>	Refractive index.
<i>p</i>	Absolute pressure.
[<i>P</i>]	Parachor.
[<i>R</i> _v]	Molar refraction.
<i>s</i>	Specific gravity.
<i>T</i>	Absolute temperature.
<i>v</i>	Volume fraction.
<i>V</i>	Molar volume.
<i>x</i>	Mole fraction.
α	Coefficient of isothermal compressibility.
β	Thermal coefficient of cubical expansion.
ρ	Density or electrical resistivity.

Subscripts

<i>b</i>	At the normal boiling point.
<i>c</i>	At the critical point.
<i>D</i>	Based on the sodium D line.
<i>i</i>	Of component <i>i</i> .
<i>L</i>	Of the liquid.
<i>m</i>	Mixture value.
<i>P</i>	At constant pressure.
<i>r</i>	Reduced quantity.
<i>T</i>	At constant temperature.
<i>11</i>	Denotes self-diffusion.
1, 2	Components 1 and 2 or temperature levels 1 and 2.

Superscript

^o	At low pressure.
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McGowan Parachor Contributions—Table I

C	47.6	Be	59.1	Ge	93.3	Te	104.6
H	24.7	B	53.4	As	87.6	I	98.9
O	36.2	He	19.0	Se	81.9	Xe	93.2
N	41.9	F	30.5	Br	76.1	Pb	113.8
S	67.7	Ne	24.8	Kr	70.3	Bi	108.1
Cl	62.0	P	73.5	Sn	116.0	Po	102.4
Si	79.2	Ar	56.3	Sb	110.3	Rn	90.9
						Al	96.7

Estimate Coefficients of Cubical Expansion and Isothermal Compressibility—Table II*

Relation	Eq. No.	Accuracy	Remarks
$\beta L_v = 9.4$	(11)	$\pm 10\%$ for 63 organic liquids.	Not accurate for water, liquid metals or inorganic liquids. $\beta L_v' = 10.1$, $\pm 4\%$ for 37 hydrocarbons.
$\beta T_b = 0.434$	(12)	$\pm 6\%$ for 63 organic liquids.	For 37 hydrocarbons, $\beta T_b = 0.464$ within $\pm 7\%$.
$L_v^2 \alpha / V = 53.6$	(13)	$\pm 6\%$ for 42 organic liquids.	Data cover a 100 to 300 atm. pressure range.
$T_b^2 \alpha / V = 0.105$	(14)	$\pm 7\%$ for 42 organic liquids.	Data cover a 100 to 300 atm. pressure range.
$V \beta^2 / \alpha = 1.65$	(15)	$\pm 13\%$	

* See Ref. 14 for source of these methods on liquid phase properties. Units are: L_v = cal./gram mole at T_b ; L_v' = cal./gram mole at 25 C.; T_b = °K.; V = ml./gram mole; α = 1/atm. and β = 1/°K. Note: α and V evaluated at 20 C.

to be accurate within approximately 1% for 0 C. < t < 1,300 C.

Latent Heat of Vaporization

Li and Canjar¹⁰ have demonstrated the excellent data representation of an essentially simple comparative correlation for L_v .

$$(L_{vc})_{pr} = \frac{L_{vc}'}{L_{vw}'} (L_{vw})_{pr} \quad (16)$$

where $(L_{vc})_{pr}$ is L_v of any compound at a given reduced pressure; L_{vc}' is L_v of compound at T_b , L_{vw}' is L_v of water at a reduced pressure corresponding to the T_b of the given compound, and $(L_{vw})_{pr}$ is L_v of water at the given p_r . For 21 compounds at a number of reduced pressures each, the maximum value of $(L_v)_{111}$ — $(L_v)_{calc.}$ was 12 Btu./lb.

Diffusion Coefficients

For estimating the diffusivities of binary gas mixtures, Slattery²⁰ has proposed that two reduced quantities be combined as follows:

$$(pD_{12})_r = a(T_r)^b \quad (17)$$

where

$$T_r = T/(T_c T_c)^{0.5} \quad (18)$$

and where

$$(pD_{12})_r = \frac{pD_{12}[2M_1M_2/(M_1+M_2)]^{0.5}}{(p_1 p_2)^{1/2} (T_c T_c)^{0.5/2}} \quad (19)$$

where units for D_{12} are cm.²/sec.; p , atm. and T , °K.

For self-diffusion and for mutual interdiffusion of nonpolar gases, $a = 3.882 \times 10^{-4}$ and $b = 1.823$. For interdiffusion of steam and a nonpolar gas, $a = 5.148 \times 10^{-4}$ and $b = 2.334$. The average error in D_{12}

computed by this method is about 9%. Therefore, this method ranks among the two or three best prediction methods for this transport property.

An excellent over-all review of the theory of diffusion, in both gaseous and liquid phases, has been published by Bird.²¹ In this review, a generalized chart, prepared by Slattery, of $(pD_{12})/(pD_{12})^\circ$ vs. T_r and p_r up to a p_r of four was presented.

The same chart with an extrapolation up to p_r equal to 10 was later published by Slattery and Bird.²² This chart is directly applicable to estimation of the pressure dependence of self-diffusion coefficients. However, its accuracy has not been fully assessed.

It has also been suggested that the same chart might be used to estimate the pressure dependence of binary diffusion coefficients by using pseudocritical T and p . However, insufficient data exist for adequate testing.

In our original treatment²³ of gaseous diffusivities, we pointed out that D_{12} does not vary very much with composition. A quantitative estimate of the maximum error incurred by this assumption may be made with the following equation:²⁴

$$\frac{(D)_{y1}}{(D)_{y2}} = \frac{1 + [M_2^2/(12M_2^2 + 16M_1M_2 + 30M_1^2)]}{1 + [M_1^2/(12M_1^2 + 16M_1M_2 + 30M_2^2)]} \quad (20)$$

where D_{y1} equals D when the concentration approaches zero for component 1, and D_{y2} is the analogous quantity for component 2.

A good reference for up-to-date information concerning thermal dif-

Group Heat Capacity—Table III¹⁶

	Contribution,* Cal./(Gram Mole)(°C.)
CH ₃ —	9.9
—CH ₂ —	6.3
>CH—	5.4
—COOH	19.1
—COO— (esters)	14.5
>CO (ketones)	14.7
—CN	13.9
—OH	11.0
—NH ₂ (amines)	15.2
—Cl	8.6
—Br	3.7
—NO ₂	15.3
—O—	8.4
—S—	10.6
C ₆ H ₅ —	30.5
H— (formic acid, formates) ¹⁷	3.55
=CH— (allyl compounds)	5.4

* At 20 C. only. Note: For certain atomic configurations, it may be necessary to use values for C alone and for H alone; the author found -0.8 and 3.6, respectively, adequate.

fusion in gases is an article by Chapman.²⁵

A review of recent work on gas and gas mixture diffusion, as well as a wealth of other property information, is included in a recently published book,²⁶ which is highly recommended to anyone involved with physical properties.

Thermal Conductivity

Supported by new experimental data, Sakiadis and Coates²⁷ extended their earlier prediction method²⁸ for

the thermal conductivity of liquids to ring compounds. Wang and Knudsen²⁸ considered the k of liquid-liquid emulsions and compared their data for emulsions of water and petroleum solvent, mineral oil, and carbon tetrachloride with three equations.

None of the equations was especially accurate, but the one exhibiting the least extreme deviations represented the data within 20 to 30% and is:

$$\frac{1}{k_e} = \frac{v_w}{k_w} + \frac{v_o}{k_o} \quad (21)$$

where v is phase volume fraction and subscripts e , w and o denote emulsion, water and oil respectively.

A reduced k correlation for both liquid and gaseous hydrogen over the ranges $0.2 < k_r < 10$, $0.1 < p$, < 100 , and $0.6 < T_r < 46$ was developed by Schaeffer and Thodos.³⁰ A reasonably successful correlation³¹ for new data on the k of suspensions of graphite in silicone oil and in water has appeared. Calculation of the k of porous and other composite materials such as snow has been well reviewed by Woodside.³² Novikov³³ has noted an empirical relation between the thermal conductivities and viscosities of saturated liquid and vapor phases.

Ewing and others³⁴ developed a broadly applicable equation for the k of metals whether pure or alloyed, liquid or solid. This relation correlates the available data for liquid metals within 5 to 10% and for solid pure and alloyed metals within 4 to 7%. It also appears to work well for simple unassociated organic liquids. The relation is:

$$k = (2.61 \times 10^{-8})(T/\rho) - (2 \times 10^{-17})(T/\rho)^2/C_p d + 97C_p d/MT \quad (22)$$

where k is watts/(cm.) (°C.); T is °K.; ρ is electrical resistivity, ohm-cm.; C_p is specific heat, cal./(gram) (°C.), d is density, gram/cc. and M is atomic or molecular weight. Use average weight for alloys.

Studies of the enhanced k of gas mixtures in chemical equilibrium have been the subject of considerable recent interest.³⁵⁻³⁸ These studies rely mainly on data for the system: $N_2O_4 = 2NO_2$. The studies also give methods by which these data are successfully correlated.

Validity of the Lindsay-Bromley formula³⁹ for gas mixture k was corroborated⁴⁰ for ternary gas mix-

tures of neon, argon and krypton. Rubin⁴¹ proposed a simple relation suitable for the calculation of the k of gas mixtures containing hydrogen:

$$k_m = f \left[\left(\frac{x_1 + w_1}{2} \right) k_1 + \left(\frac{x_2 + w_2}{2} \right) k_2 \right] \quad (23)$$

where x and w are mole and weight fractions, respectively. The dimensionless factor f has values given as follows:

Mole fraction H_2	0	0.3	0.4	0.5	0.7	0.9	1.0
f	0.92	0.95	0.97	1.02	1.14	1.21	1.22

Eq. (23) correlated the k of seven hydrogen-containing binaries within 3.3% and 8.6% average and maximum errors.

Friend and Adler⁴² evaluated a cube root rule for the k of gas mixtures which had been suggested by E. W. Riblett of the M. W. Kellogg Co. This relation is:

$$k_m = \frac{\sum x_i k_i (M_i)^{1/3}}{\sum x_i (M_i)^{1/3}} \quad (24)$$

The relation given by Eq. (24) is of the same form as the square root rule for gas mixture viscosity dis-

cussed earlier in this series. Average and maximum errors⁴² of 2.7% and 9.5% were found for Eq. (24) for the 19 gaseous binaries for which data were given in the Lindsay-Bromley article.³⁹ Temperature range of the data was from 273 to 353 °K. The Lindsay-Bromley formula, though much more involved, proved only slightly more accurate giving average and maximum errors of 1.8% and 6.3%. Eq. (24) is recommended for general use.

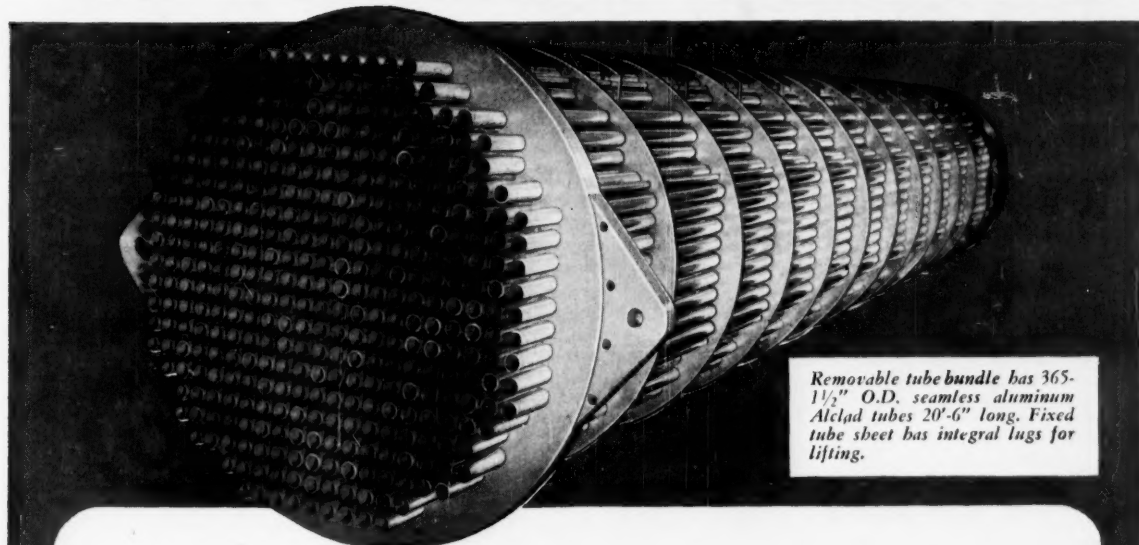
Leng and Comings⁴⁴ present two correction charts for the earlier Comings-Nathan generalized correlation for the pressure-temperature dependence of gas k -values. These charts give the correction as a function of T_r , p , and the number of degrees of vibrational freedom per molecule.

A reduced state correlation for the k of the inert gases, He, Ne, Ar, Kr and Xe has been developed by Owens and Thodos.⁴⁵ This relation was recently further developed for diatomic gases in *AIChE J.*, Sept. 1959. The k of polyatomic gases has been further studied by Hirschfelder⁴⁶ and by Knuth.⁴⁷

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HEAT TRANSFER EQUIPMENT

Compute Labor Needs for Painting

The information in this Cost File is from a handbook for training engineers in maintenance cost estimating. Use of labor factors makes it possible to apply

local wage rates to these tasks. Mr. Clark is an officer of the American Assn. of Cost Engineers.

Labor Factors: Interior & Exterior Building Painting

Preparation

Siding; sand and putty.....	200 sq. ft./man-hr.
Trim; sand and putty.....	100 lin. ft./man-hr.
Walls; wash.....	100 sq. ft./man-hr.
Remove varnish.....	30 sq. ft./man-hr.

Painting*

Cement block; waterproof...	175 sq. ft./man-hr.
Corrugated siding.....	240 sq. ft./man-hr.

Stucco; oil paint.....	90 sq. ft./man-hr.
Stucco; cement paint.....	150 sq. ft./man-hr.
Plaster; flat finish.....	175 sq. ft./man-hr.
Plaster; enamel finish.....	175 sq. ft./man-hr.
Wood trim.....	150 lin. ft./man-hr.
Doors.....	150 sq. ft./man-hr.

*All labor is based on first coat; for additional coats, add 25-30% to productivity. Use judgment for unusual circumstances that might affect labor.

Labor Factors: Industrial Painting

Determine total labor factor for a specific job by adding factors descriptive of job conditions (tabulated below) to the base factor, 1.0. Assumptions for the base-factor case appear, for each job condition, as the "zero-factor" case. When total factor is compiled, multiply it by the base case productivity, 3.0 man-hr./100 sq. ft. to determine total man-hr./100 sq. ft. for your job. Remember that every job has portions ranging from very simple to extremely difficult conditions. Consider these portions individually for best use of these factors.

Paint Material

Oleoresinous, alkyls, phenolics.....	0.0
Chlorinated hydrocarbon resin.....	0.1
Chlorinated rubber, vinyls.....	0.3
Maintenance neoprenes, epoxys, paints requiring accelerator addition.....	0.6

Application

One coat, brush.....	0.0
One coat, spray.....	0.2
One coat, roller.....	0.3
Additional coat, brush.....	0.4
Two coats, one each by brush and spray...	0.2
Two coats, brush; or three coats, one brushed and two sprayed.....	0.4
Four coats, one brushed and three sprayed...	0.6
Three coats, brush; or five coats, one brushed and four sprayed.....	0.8

Surface Condition

Loose surface dirt, easily removed by wire-brushing.....	0.0
Light pinpoint or powdery rust.....	0.3
Occasional blisters or rust patches.....	0.6

Pretreatment

No wash.....	0.0
Light rinse or neutralizing.....	0.2
Scrubbing.....	0.4
Each wash between coats.....	0.2

Surface Configuration

Plane surface.....	0.0
Occasional projections—bolts, rivets, lap welds, etc.....	0.5
Heavy structural members.....	1.0
Light structural members.....	2.0
Lattice, grating, etc.....	3.0

Rigging

No rigging.....	0.0
Ground and ladders.....	0.5
Ladders only.....	1.0
Swing stage and ladders.....	1.5
Scaffolding or other complicated rigging...	2.0

Job Interference

No interference.....	0.0
Remote from shop; outside job.....	0.1
Slight interference (remoteness plus outside job).....	0.2
Moderate interference (requires coordination with production).....	0.4
Heavy interference and interruption.....	0.6

Environment

Comfortable conditions.....	0.0
Gas influence (applied when work is in known offending areas).....	0.2
Moderate temperature or humidity influence...	0.3
Severe temperature or humidity influence...	0.4

Posture

Standing on firm footing, painting at trunk height.....	0.0
Stooping, kneeling, sitting.....	0.3
Crawling and reaching.....	0.6
Lying, crawling, reaching.....	0.9

KENNEDY Coke-calcining Kilns

Mountaineer Carbon Company achieves higher yields and better quality of their new Cresap, W. Va. coke-calcining plant—with a KENNEDY Kiln and KENNEDY Kiln Accessories.

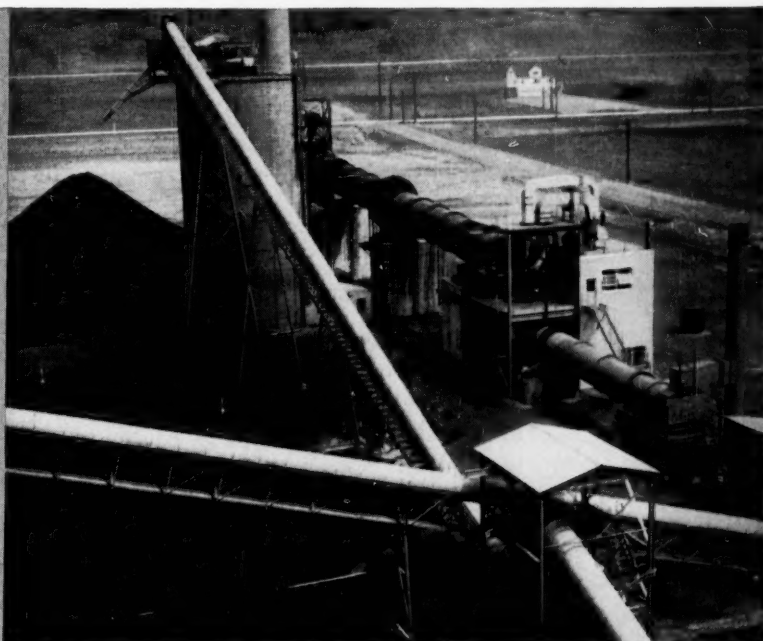
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Mountaineer averages better than 75% yield, several percentage points higher than older installations. And the coke is more uniform in density.

Mountaineer gains these advantages through close control of combustion. A single gas-fed burner in hood at discharge end of kiln generates a temperature of about 2,500 F. Flame configuration, primary and secondary air flows are all controlled carefully; seals cut leakage of unwanted air.

This close control of combustion allows some burning of cracked gases from coke bed. Yet, it prevents unwanted combustion of carbon which reduces yields in most coke calcining. Too, it produces uniform density in finished product, a direct result of uniform temperature.

Kiln is 180 ft. long and 10.5 ft. in dia. Rotating at about 1 rpm., it retains coke approximately 100 min.



KENNEDY equipment is behind the high performance record of this new plant:

- The 180' long kiln with its bronze sleeved, self-aligning bearings, 3-tire supports and drive assembly;
- Special feed and discharge air seals which reduce air leakage and improve combustion control;
- The kiln firing hood with its extra large access doors for maintenance;
- The air cooled nose ring assembly, specially designed by KENNEDY for coke-calcining.

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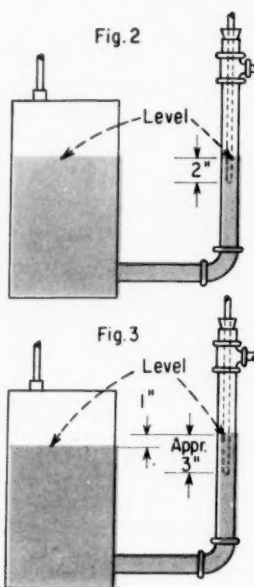
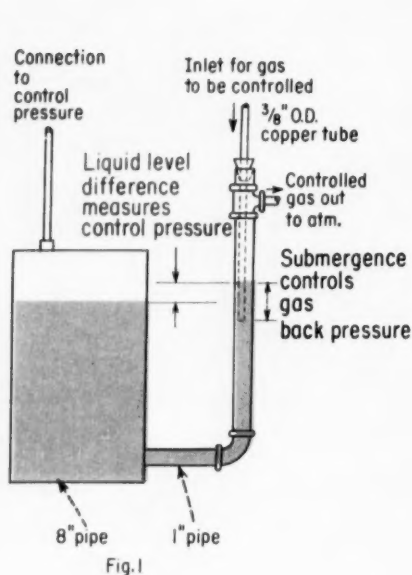
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Hydraulic Seal Controls Differential Pressure

By using a hydraulic seal of depth varying with a control pressure, a second pressure can be held to a definite differential vs. the first.

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M. S. Schwartz

United Engineers & Constructors Inc., Philadelphia 5, Pa.

Sketched above in Fig. 1 is a simple hydraulic seal device which we have used successfully in development work to hold a constant differential pressure between an outgoing gas stream and some other pressure in the system which might fluctuate. Figs. 2 and 3 illustrate the action of the device when the control

pressure is fluctuating. In our use of this method it has held a differential of 4 to 6 in. H_2O with an accuracy of $\pm \frac{1}{2}$ in.

The controller consists of two vertical pipes of widely differing diameter, joined together at the bottom to form a manometer which is filled with water or another suitable liquid. In our case

the pipes were respectively 8 in. and 1 in.

The top of the larger pipe is connected to the source of the control pressure so that the difference in liquid level in the two pipes is now a measure of the control pressure above or below atmospheric. A $\frac{3}{8}$ -in. O.D. copper tube introduces the gas to be pressure-controlled below the surface of the liquid in the smaller pipe. This forces the gas to bubble through the liquid before it escapes from the system through the side pipe. The submergence of the copper tube at any time governs the back pressure that must build up before the gas can escape.

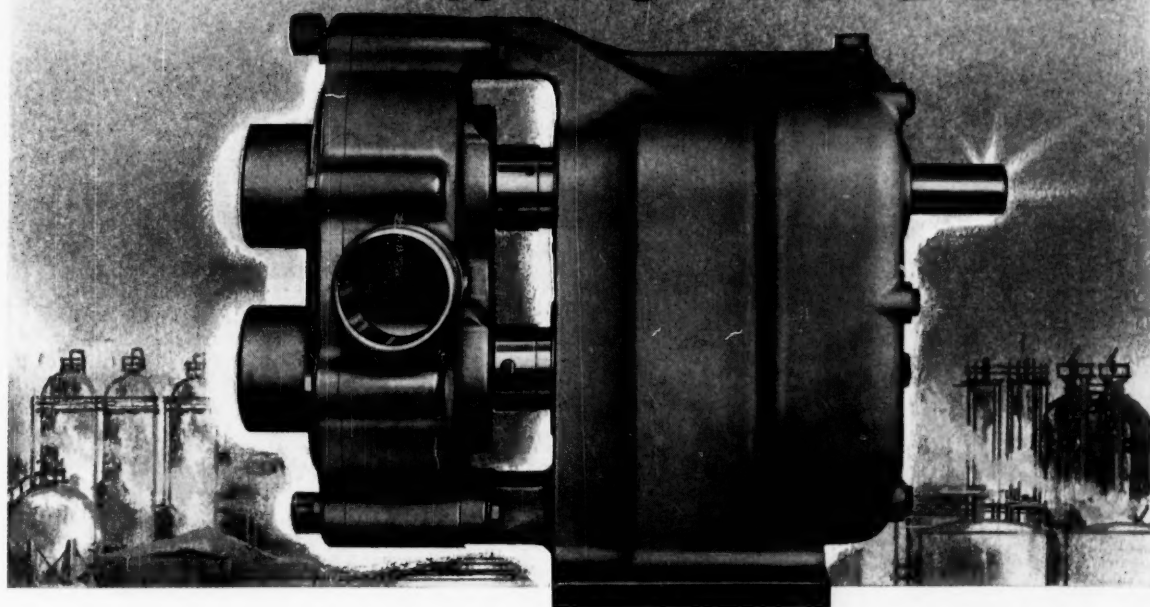
Fixing the depth of the copper tube automatically sets the pressure differential. For example (see Fig. 2), when the control pressure is atmospheric, if the submergence of the tube is 2 in., then the controlled gas pressure will have to be 2 in. H_2O before gas can bubble through. Assume now (see Fig. 3) that the control pressure increases to 1 in. H_2O . The level difference in the two legs of the manometer will become 1 in. which will increase the tube submergence to 3 in. (approx.). Although the control pressure has now changed, the 2-in. differential still holds approximately.

The reason why the control is approximate rather than exact can now be considered. We noted above that the changes in the controlled pressure are determined by changes in the level in the smaller leg. However, changes in the control pressure are measured by the difference between the two legs. Therefore, the greater the area difference between the legs (60 to 1 for 8-in. and 1-in. pipe), the closer will level changes in the smaller leg represent level differentials between the two legs. In our case, for example, a control pressure change of 1 in. will give a level change in the smaller pipe of very close to $1 - \frac{1}{64}$ in., or about $\frac{63}{64}$ in.

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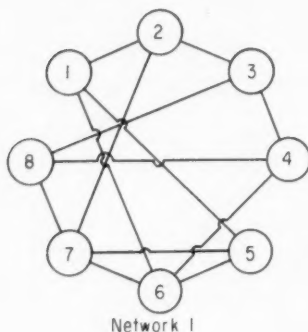
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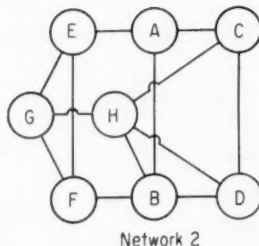
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	1	2	3	4	5	6	7	8
1	0	X	0	0	X	X	0	0
2	X	0	X	0	0	0	X	0
3	0	X	0	X	0	0	0	X
4	0	0	X	0	0	X	0	X
5	X	0	0	0	0	X	X	0
6	X	0	0	X	X	0	X	0
7	0	X	0	0	X	X	0	X
8	0	0	X	X	0	0	X	0



	A	B	C	D	E	F	G	H
A	0	X	X	0	X	0	0	0
B	X	0	0	X	0	X	0	X
C	X	0	0	X	0	0	0	X
D	0	X	X	0	0	0	0	X
E	X	0	0	0	0	X	X	0
F	0	X	0	0	X	0	X	0
G	0	0	0	0	X	X	0	X
H	0	X	X	X	0	0	X	0

Check Similarity of Networks

Joseph T. Hogan

Chemical Engineer, Arabi, La.

Chemical engineers often face the problem of determining whether two "networks" are similar in structure. The term "network" can refer to an organization chart, a flow diagram, an electrical or electronic circuit, communication between departments, flow of information within a computer, logistical routes, etc. It is sometimes hard to tell whether two such networks are actually different, or simply appear different because of a different arrangement.

The diagrams above show two networks which appear different. Our problem is to find whether this is the case. Use of incidence matrices provides a simple solution. The incidence matrix for each network appears below it in the diagram.

The matrix consists of an arrangement of columns and rows identified as in the units of the network. If communication exists between two units as shown

by a line connecting them in the diagram, then X is placed in the proper row and column. For example, in the first network, Unit 1 connects with Units 2, 5 and 6. In the incidence matrix this is shown by X in Row 1 under Col-

umns 2, 5 and 6. Conversely, if there is no communication between units, a zero is used. Incidence matrices are prepared for both networks.

To show the networks similar, it is necessary to be able to rearrange the incidence matrix for the second network in some fashion so as to have the same pattern as that of the first. This is accomplished by successively interchanging rows and columns. For example, a valid interchange would be to place Row C above Row A, and Column C before Column A in the second matrix.

After a certain amount of experiment we find for the case given here that the successive rearrangement of Matrix 2 to CAEGDHBH yields a matrix identical with that for Network 1. This means that the two networks are identical in structure. Thus, in the two networks, the corresponding units are C and 1, A and 2, E and 3, G and 4, D and 5, H and 6, B and 7, and F and 8. If we had been unable to make such an arrangement, it would have indicated dissimilarity.

Although the interchange of rows and columns can be done with a pencil, the easiest way is to mark each entry (X or O) on a small square of cardboard. Transposing rows and columns becomes easy by sliding each row or column into its new position.

For further information on matrices the reader is referred to Perlis, "Theory of Matrices," Addison-Wesley Press, Boston, 1952; or Nat. Bur. Stds. Tech. News Bull., May 1958.

NEXT ISSUE: Watch for November Contest Winner

★ How Readers Can Win

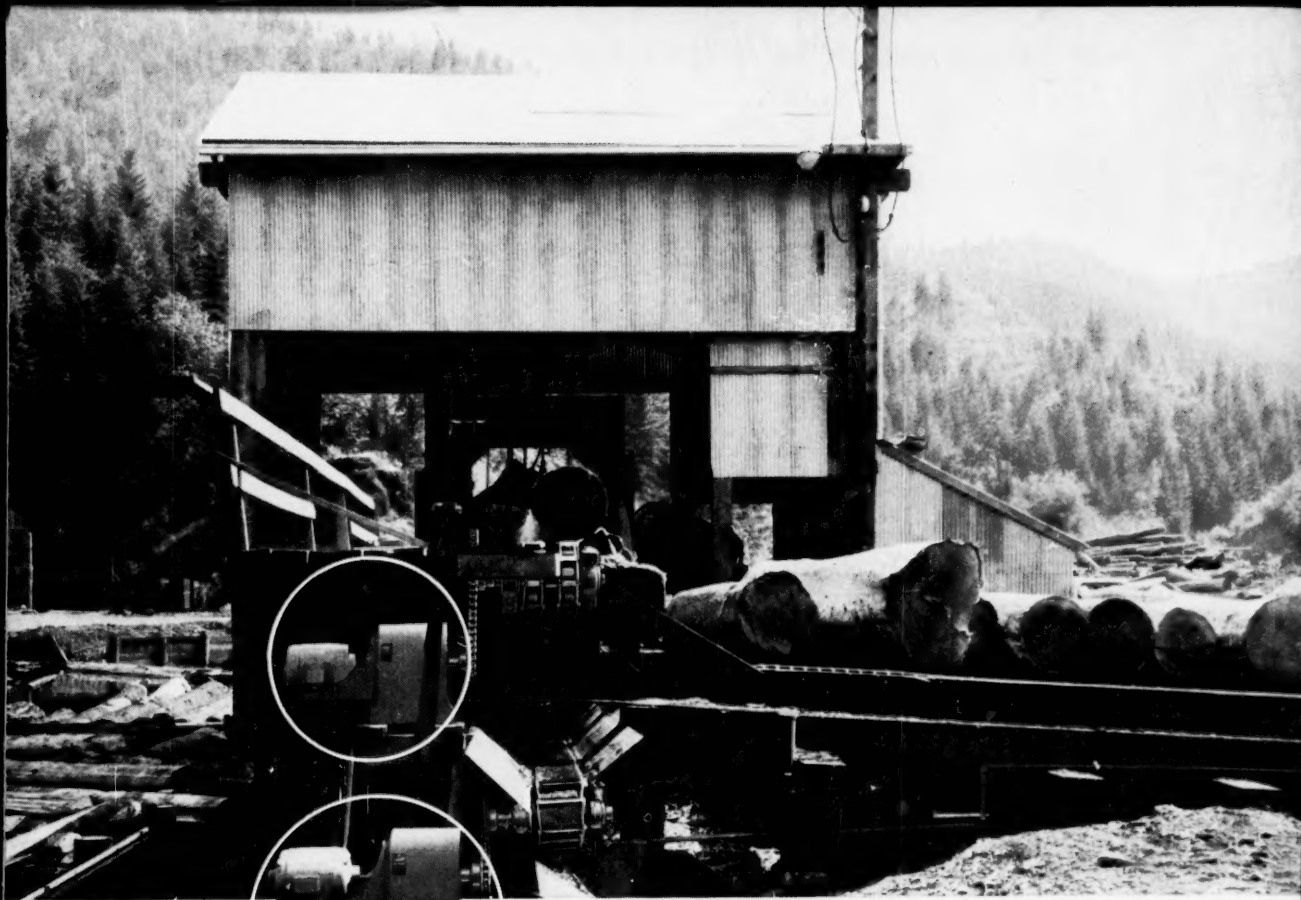
\$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award \$50 each four weeks to the author of the best short article received during that period and accepted for Plant or Process Design Notebook.

Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

\$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional \$100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at space rates (\$10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Process Design Notebooks, *Chemical Engineering*, 330 W. 42 St., New York 36, N. Y.



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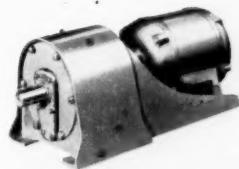
All-steel construction is one of the built-in extras that you get in Falk Motoreducers. Others include: (1) 12 to 15% reserve load-carrying capacity in the gears (by AGMA standards), thanks to exclusive Falk extra-depth, high pressure angle helical gears; (2) maximum mechanical efficiency (98½% per gear mesh, under full load); (3) your choice of standard units (horizontal, vertical or right angle) to fit your precise requirements.

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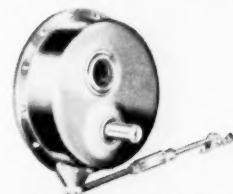
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PRACTICE ...

YOU & YOUR JOB

EDITED BY R. F. FREMED



You Told Them You're Unhappy

Conflict between the engineering mind and the management mind is still a fundamental and unresolved problem in American industry, according to a study just released by Opinion Research Corp. (ORC), Princeton, N. J.

ORC reports that engineers and scientists working for large corporations are anything but happy with their lot. This conclusion is based on extrapolating the results of a six-company study, which involved interviews with 622 technical men and with 105 managers in representative companies in the aircraft, chemical, drug, electrical and electronic equipment, petroleum and rubber industries.

Of the engineers and scientists interviewed, 72% com-

plained that management misuses their talents; 71% maintained that their companies force them to overspecialize; and 67% contended that getting ahead in

management is more a matter of politics than knowledge.

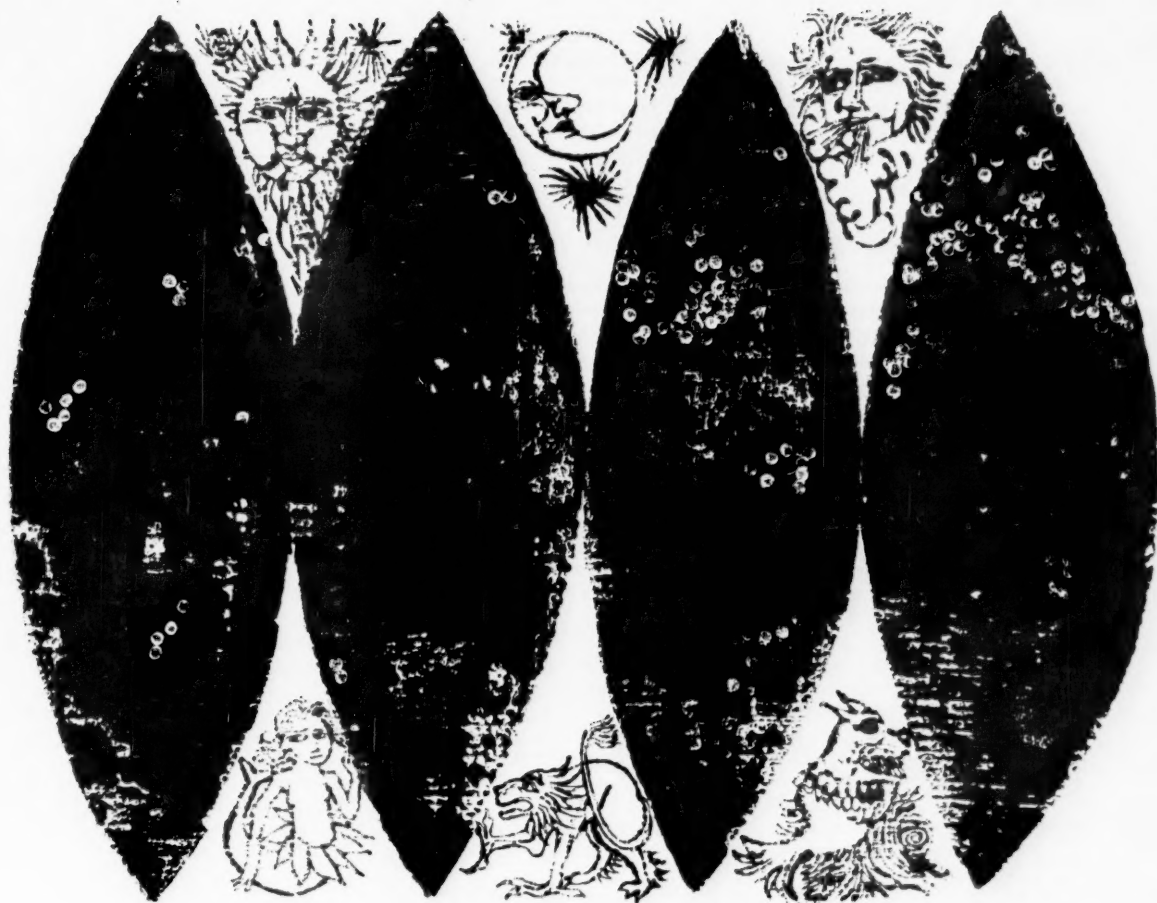
In addition 75% complained that corporate pressures did not permit them the freedom to

Basic Conflicts Between Managers and Engineers

Unrealistic expectations of engineers. They have a desire for status and freedom from work pressures that are hard to meet in a corporation; their expectations are more appropriate to private, professional practice.

Little appreciation for management methods. Engineers often fail to grasp management methods such as the nature of risk-taking and the managerial process of decision-making.

Lack of respect for differing contributions. There is a lack of mutual respect for the different skills and competences of managerial and technical groups. Each tends to evaluate the other's accomplishments and rewards by the standards of his own group, which are inappropriate for the other.



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Get specific information by discussing your process needs and plant requirements with Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N.Y.—or write for a copy of the new fully-illustrated booklet describing FW's services.

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"work in their own way," and 80% of the engineers and scientists interviewed complained that they were underpaid, when com-

pared with others with similar training and responsibilities.

You might think that ORC had stumbled onto a poor sample of

very unhappy people. But the companies selected are all large, successful corporations, major companies in their respective fields and deeply engaged in scientific research. The sample of professionals is made up of high-talent, well-educated people; half have advanced degrees; 30% have doctorates.

► **Basic Conflicts** — The study singles out several factors that appear to breed conflict between a company's management and its technical personnel. We've summarized these factors in the display type which begins on p. 180.

Next, ORC enumerates the reasons for the existence of these factors that cause friction. Finally, the report suggests several constructive steps and new approaches that may be used to heal the breach. These also are highlighted in the accompanying display.

As issued by ORC (on a confidential basis, for use by clients only) the report is available in two forms. The complete research analysis is available as "The conflict between . . . The Scientific Mind and the Management Mind." For those who want to scan the results rapidly, an executive summary has been ingeniously inserted into the cover of the longer report.

This, in itself, is a clue to the basic conflict. The engineers will undoubtedly read every word and pore over every bar chart and table of data in the long research report. Members of the management team will be able to glean the significance by a quick glance at the executive summary.

► **Available to Others** — Although the original results are available only to clients of ORC, other companies may be able to have access to this accumulation of knowledge in the field of fundamental problems of motivating engineers and scientists.

The project was directed by Robert D. Best. ORC will make him available for consultation to "member companies" who wish to discuss the utilization of high-talent manpower and technical professionals. (CE did not discuss with ORC the cost of becoming a "member company.")

► **The Union Threat**—ORC con-

Here Are the Reasons for the Conflicts

Engineers expect a leisurely work pace and a peaceful work environment. These are difficult to provide in a corporate organization.

We make the great contribution, engineers and scientists say; but management gets the rewards and recognition.

Management is seen as having political acumen. But engineers and scientists place low value on this kind of competence.

Management controls the avenues to advancement and many engineers feel that they don't get a fair shake.

Symbols of professionalism for members of management are not readily recognizable. Therefore, it's easy for engineers and scientists to doubt the professional competence of their superiors.

The technical man aspires to the professional status of the private practitioner. This is another force breeding discontent in the engineer who has to earn his living by working for a corporation.

A self-image of genius plagues scientists and engineers. They think that they should work primarily on "big new ideas."

Management misuses me. This is a broad-scale complaint voiced by engineers and it follows logically from the man's view of his own talents.

Matching company goals. Scientists and engineers have difficulty fitting their work into the larger context of company goals.

Corporate system of recognition, while it suits management, does not work as well for engineers.

These New Approaches May Resolve the Conflicts

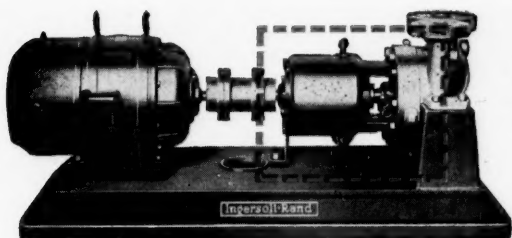
More interpretation of managerial decisions. Everyday decisions to limit funds or to terminate projects upset the technical man's world. He needs the "why" and he says that he's not getting it now.

New order of personal recognition. Management basks in the reflected glory of a successful company. Engineers and scientists get their kicks through personal recognition for successful individual effort.

New measures of technical contributions. Management inevitably judges people by cost performance, teamwork—criteria they haven't sold to the technical man. He wants to be evaluated primarily on technical competence for which no accurate measures now exist in industry.

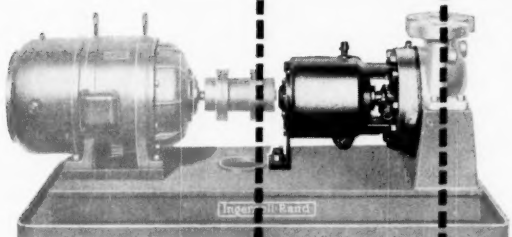
Realism in recruiting. Engineers want to be given a sober appraisal of what expectations can and cannot be realized in the company. This will help to minimize future disappointments.

New relations with universities. More professors with an industrial background can help inject into the college curriculum the realities of competitive corporate life. New emphasis is needed in the curriculum on the role that an engineer will play as an employee of a corporation.



This "multi-process" pump now handles a wider range of applications

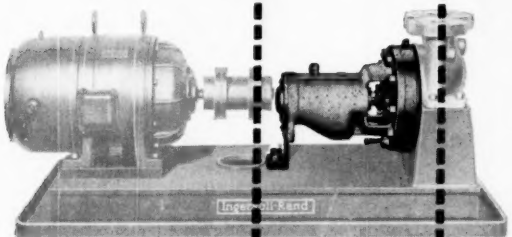
with unequalled interchangeability of parts



Here's how Ingersoll-Rand
"tailors" its SFL line of heavy-duty
pumps to meet your process
requirements at least cost:

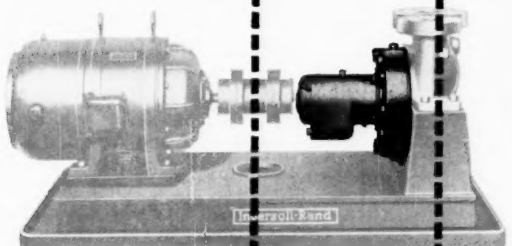
SFL . . . high-temperature service up to 800°F.

This is the basic water-cooled heavy-duty pump which has gained industry-wide acceptance for ruggedness and long-term dependability. It is designed specifically for hot-liquid services and is available with packed box or mechanical seals.



SFLM . . . medium temperature up to 300°F.

Take away the water-jacketing from the SFL and you have the SFLM . . . the same rugged pump at a lower first cost, designed for medium-temperature service. Should you later decide to put this pump on high-temperature service, you can easily convert it to water-cooled operation. Simply change to a water-cooled stuffing box extension and bearing housing. Available with packed box or mechanical seal.



SFLA . . . up to 200°F . . . with built-in mechanical shaft seal as standard equipment.

The seal eliminates packing maintenance and permits complete enclosure of the seal box . . . a definite safety factor. Within its rating, the SFLA is the most economical selection with single mechanical seal.

3 designs for one basic pump...

all available with top or end suction for heads to 750 ft, capacities to 900 gpm

WITH Ingersoll-Rand's newly extended line of "multi-process" pumps, you can now select from three basic types . . . and get exactly the pump you want for each specific application. You get maximum interchangeability of parts, plus the first-cost economy which results from a basically standard production model.

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manufactured by Ingersoll-Rand, you can be sure that your I-R pump specialist will give you objective, expert counsel. Ingersoll-Rand makes the most complete line of centrifugal pumps available for the process industries.

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THERE'S NO SUBSTITUTE FOR EXPERIENCE IN ENGINEERED PRODUCTS

CHEMICAL ENGINEERING—December 14, 1959

183

tends that the accelerated growth of technical professionals in industry is forcing management to re-examine its policies concerning this important group.

Scientists and engineers have spawned into a mass group. Current growth rate is more than eight times that of the labor force generally. During this period of industrial growth, the number of blue-collar jobs in some industries is actually declining while technical jobs are increasing. The technical group is now searching for leadership in these two ways:

- Some 50,000 scientists and engineers have already gone the union route, many in leading companies known for their enlightened personnel practices. (One of the six companies in the ORC survey already has a professional union.)

- Professional societies are feeling the mounting pressure for more vigorous action to improve professional status and to protect the technical professional's interest.

► **Professional Status Wanted**—Company scientists and engineers continually evaluate their professional status in contrast

with the entrepreneurial professional—the MD, lawyer, architect, the consulting engineer. They overlook the basic differences between the two classes of professionals.

Entrepreneurial professionals provide their own capital; have fee-basis risks; work unlimited hours; have independence of work habits; are responsible for directing their own work; and belong to exclusive associations such as the American Medical Assn., etc.

On the other hand, the employee professional doesn't raise his own capital, management does it for him; has monthly paycheck security; works regular hours; must work with teammates; must meet the boss's requirements; is trained en masse; and he's wide open to a multitude of contending technical and professional societies and groups.

► **Two Different Minds**—When the scientific or engineering mind is contrasted with the management mind, ORC came up with these answers to its questions:

- Management mind is integrative. It has to make decisions on limited information; has to take risks regularly; must focus on practical results; its approach is to over-simplify.

- Engineering or scientific mind is analytical. It wants to investigate all angles in a decision; tries to postpone risk-taking; is concerned with the theoretical; its approach is to elaborate and add detail.

Will these conflicts ever be resolved? Will some way be found to satisfy the unfulfilled expectations of the technical man without allowing him to find attraction in the union route? ORC offers some constructive approaches to possible solutions.

Of particular interest to this observer is this conclusion which may be drawn from the results: Once again we find that there is absolutely no correlation between productivity and morale. For the engineers in this survey who claim to be so unhappy are among the most productive in American industry. Maybe they ought to be whipped a little harder.



Can Your Employer Qualify for This New Award?

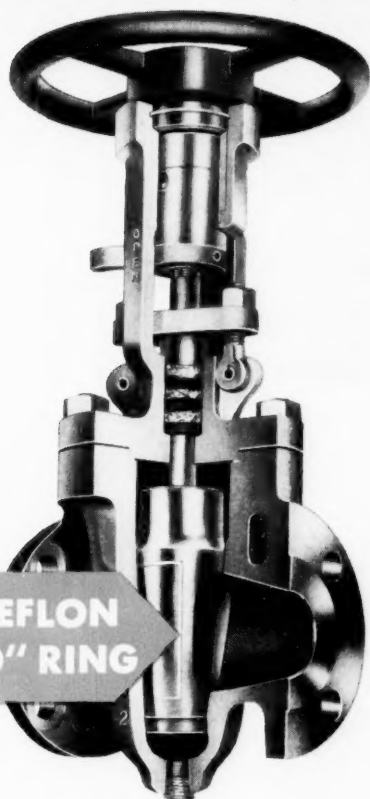
Shown above is the plaque that will be presented next June to the first recipient of the new "Industrial Professional Development Award."

Sponsored by the National Society of Professional Engineers (NSPE), the award will recognize the company that has made an outstanding contribution to the advancement and improve-

ment of the engineering profession through the adoption of forward-looking employment practices for its engineers.

There will be only one winning company each year, but NSPE hopes that the establishment of the award will encourage all industrial employers of engineers to adopt professional employment practices.

STOP!



TEFLON
"O" RING



No
Lubrication Ever
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"O-SEAL" VALVE!

It never leaks!

Why is Stockham's new Wedgeplug "O-Seal" valve the hottest thing in the industry? Because it solves your leakage and lubrication problems—for good! It's non-lubricated!!

Here's how the "O-Seal" works—

Two Teflon** "O" rings, inserted in dovetail grooves machined on the face of the plug, seat on the raised body seats when the plug is in closed position. The sealing effect of these rings gives absolute shut-off in all cases—shut-off that remains permanently "bubble-tight."

Hundreds of tests of this new valve in all types of services have failed to make it leak. And it never needs lubrication!

OTHER ADVANTAGES

Provides Double-Block and Bleed in most services • Ends costly maintenance • Double seating for double safety. Ground metal-to-metal seat provides shut-off in case fire burns out "O" rings • Ends product contamination • Protected seats • Quick, easy operation—won't stick or bind.

RECOMMENDED USAGES . . .

Stockham's new "O-Seal" is recommended for all general services—air, gas, water, steam, propane, hydrocarbons, etc., as well as for hard-to-hold services. Recommended for temperatures from minus 300°F to 400°F and not exceeding 720 psi. • Available in carbon and alloy steels, 2" to 12" sizes, 150 and 300 lb. pressures. Three port openings—40%, 70%, full round. Wrench, handwheel, gear, and motor operated.

Stockham makes a **BETTER** valve . . . for **EVERY** job!

*Patented **Teflon, Dupont Trademark



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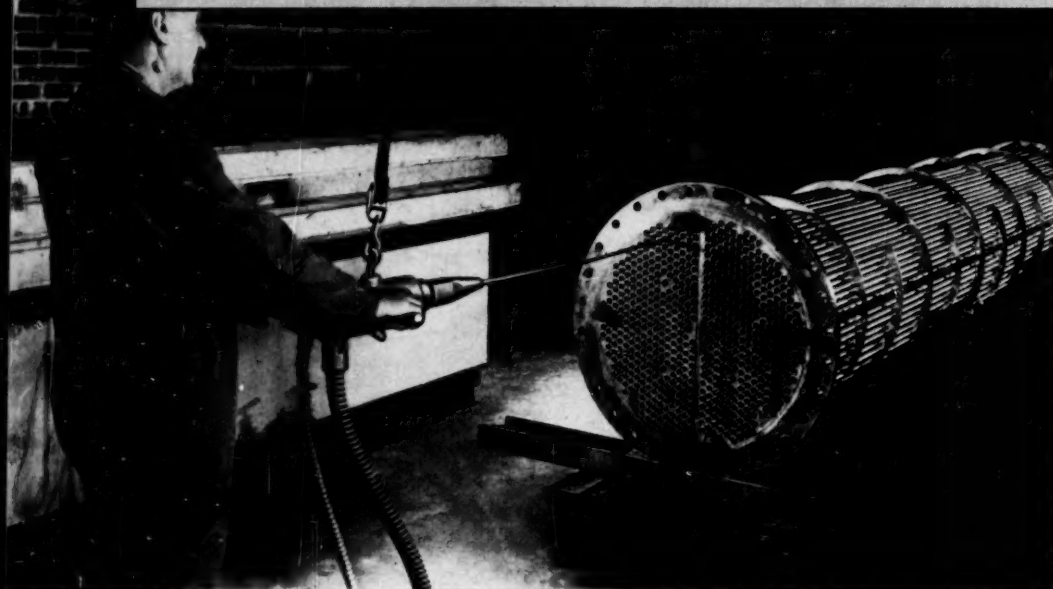
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PRACTICE . . .

OPERATION & MAINTENANCE

EDITED BY M. D. ROBBINS



Mechanical Tube-Cleaning Helps . . . Reduce Heat Loss in Exchangers

To operate heat exchangers at design capacity requires deposit-free tubes. This is the first of two articles on how cleaning and retubing help achieve this maximum efficiency.

A. JOHN, Assistant General Manager, Thomas C. Wilson, Inc., Long Island City, N. Y.

A heat exchanger does the best job when tubes are clean and deposits don't interfere with heat transfer, throughput or contribute to short tube life.

Although this is obvious, it isn't easy to make the decision to take a heat exchanger off stream for tube cleaning. It's a strong temptation to let deposits accumulate until the effects are so serious you are forced to shutdown for cleaning or retubing. This, obviously, isn't a wise procedure; a dollar of preven-

tive maintenance is usually worth a lot more than many dollars of cure.

Maintenance Means Schedules

Preventive maintenance, of course, implies a definite schedule for heat exchanger tube cleaning; fast and thorough cleaning techniques; and limited retubing or plugging procedures that help postpone the time complete retubing is needed.

A good plan for overcoming

the temptation to let matters ride is:

First—Determine from past experience, the optimum cleaning period for each individual heat exchanger.

Then—Record this along with other pertinent information on a file card.

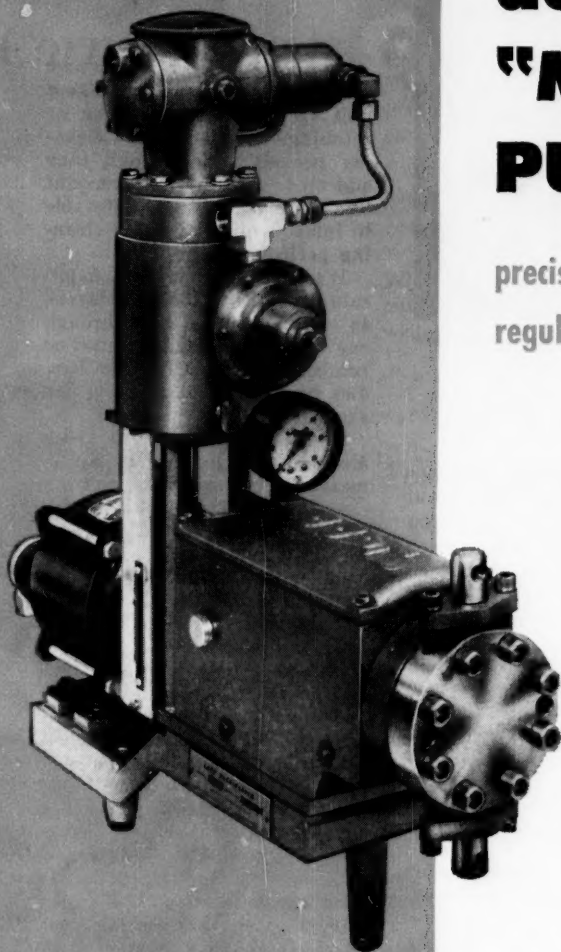
Finally — Follow religiously the schedule established by your cards.

Each card should show frequency of cleaning, nature of deposits, condition of tubes when

IT'S NEW! Lapp

auto-pneumatic "MICROFLO" PULSAFEEDER

*precise pumping at micro-flow rates
regulated by pneumatic control instruments*



Lapp

Here's a controlled-volume metering pump that will vary its microflow rate of output automatically to a changing process condition. Auto-Pneumatic Microflo Pulsafeeder is a piston-diaphragm pump with no stuffing box or other seal—it handles fluids without contamination or leakage.

Output of a standard Microflo is governed by controlling the travel of its piston. This is done manually through a micrometer. In the Auto-Pneumatic model, an air cylinder performs this operation. As a change in a process condition occurs, a pneumatic control instrument senses the change, records it and sends an air pressure signal descriptive of the changed condition. Auto-Pneumatic Microflo Pulsafeeder reads this air signal and changes its pumping rate accordingly.

Four models are available with flow rangeability of 10 to 1 and a flow range from 585 ML per hour maximum up to 1.2 gph maximum. Reagent head assembly is made from Carpenter No. 20 Stainless, Diaphragm is Kel-F and valves are Hastelloy C. Other materials are available on special order.

WRITE FOR BULLETIN 500-A containing complete description and specifications on the new Auto-Pneumatic Microflo Pulsafeeder.
Lapp Insulator Co., Inc., Process Equipment Division,
3613 Poplar Street, Le Roy, New York.



SCALE in fouled heat exchanger tubes cuts down heat transfer and flow rates, makes cleaning difficult and promotes corrosion.

last cleaned, estimated date when retubing is required, number of plugged-off tubes, equipment needed for cleaning or retubing and availability of required cleaning equipment.

Determining optimum frequency of cleaning for a heat exchanger is based on a number of considerations. Rate of deposit accumulation is obviously a prime factor, but by no means the only one. Nature of deposits is also an important factor, since many types of deposits change character as time passes. These may require not only extra cleaning time because of extra quantity of deposit, but also because of increased hardening, coking or some similar change of deposit.

Another important factor is allowable leeway in the heat exchanger's performance. How much change in temperature differential, operating pressure or throughput can you tolerate before product quality, production rate or production efficiency are affected beyond acceptable limits?

Effect of scale can be substantial. To cite a common example, in one refrigeration plant the scale removed by mechanical cleaning meant a condenser pres-

sure difference of 25 psi. For the 300-ton plant, operating 300 days/yr., this scale cost \$7,500 annually for electrical power needed by the pumps to produce the extra 25 psi.

Most heat exchangers are designed with 10 to 15% extra capacity, but it doesn't take long to lose this. A typical hard scale reduces heat transfer 12% per 1/16 in. of deposit. A typical soft deposit, 1/8-in. thick, means a 15% heat loss.

Cleaning Reduces Corrosion

Corrosion is another major consideration in deciding when to clean tubes and when to retube. Scale or other deposits often promote corrosion and, for this reason, should not be allowed to remain too long.

A decision to retube instead of clean may be forced on you by corrosion proceeding to a point leaving too little remaining tube life to make cleaning worthwhile.

Consider the number of plugged-off tubes in determining when to clean. This is because the more tubes out of service, the less ability to tolerate loss of heat transfer or throughput due to scale.

Heat Loss Through Tube Scale

Scale, in.	For Hard Scale	For Soft Scale
0	0	0
1/50	4%	2%
1/32	8%	4%
1/16	12%	10%
1/8	20%	15%

Another consideration is how long you can conveniently take a unit off stream for cleaning or retubing. Frequent short cleaning periods, even though they add up to an equivalent amount of time, may well be preferable to infrequent but lengthy cleaning periods.

It's often desirable to duplicate key units in the plant layout so you can bypass flow through one while the other is cleaned or retubed. Or, duplicate tube bundles may be maintained for the same shell.

A final consideration is available cleaning power and equipment. For example, you can't use chemical cleaning when tubes are completely plugged; nor internal air or water motors which are small enough to enter most small heat exchanger tubes. However, if you rely on these methods, tubes will have to be cleaned before becoming completely plugged or deposits solidified.

Among the many tube cleaning methods are: drilling, picking or chemical cleaning; steam, hydraulic, or air lancing; sand blasting; and shooting of plugs through the tubes by air or hydraulic pressure. Some represent the only practical means for cleaning the shell side of tubes. Others offer controversial, yet good, methods. Still, every method has its advantages and disadvantages.

Here's What to Use

For internal cleaning of tubes, mechanical cleaning by appropriate power-driven tools is the most popular "Johnny-on-the-spot" method. Almost all plants are equipped with such tools—if only because they offer the only practical means for cleaning out tubes that are completely plugged.

In many plants these are the

RYKON Grease

*passed this
test at
Corn Products
Company*

Situation: The springs in the grease chargers on expeller machines at Corn Products Company's Argo, Illinois, plant are under extra heavy tension. Due to this tension, oil formerly separated from the grease thickener in the grease cups. Bearings did not receive proper lubrication and the cups filled with grease thickener residue. The system needed cleaning every three months. Each time, large amounts of residue were found. Ten special-purpose greases were tried in an effort to solve the problem.

What was done: A Standard Oil lubrication specialist working with Corn Products' plant maintenance people recommended RYKON Grease #2 E.P. The system now needs cleaning only every six to nine months. Very little residue is found. Now RYKON Grease has become one of the important lubricating greases in use at Corn Products' Argo plant.

RYKON Grease is formulated with a unique non-soap organic thickener. The fibers of this thickener hold RYKON's fine quality base oil firmly in suspension. The grease resists water washing, high temperature and dirt contamination while providing superior lubrication to bearings of all types.

What you can do: Get more facts about RYKON Grease from the Standard Oil office nearest you anywhere in the 15 Midwest and Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago 80, Ill.**

You expect more from



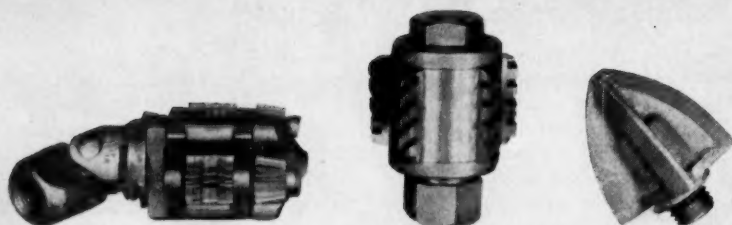
and you get it!

Standard's Arnold Parus and chief lubrication foreman Henry Anderson take a look at expeller unit's grease system. Arnold Parus is well equipped through experience and training to work with plant men on lubrication problems. Arnold has a B.S. degree from Bradley University and three years' field experience in this kind of work. He has also completed Standard's Sales Engineering School.

Quick facts about **RYKON Grease**

- Heat stable. At sustained high temperatures, RYKON Grease remains soft and grease-like.
- Resistant to water washing.
- Mechanically stable. Minimum change in consistency in service.
- Resistant to oxidation. Thickener acts as inhibitor.
- Exceptional rust preventive properties.





CLEANING BITS for heat exchanger tubes. Left, revolving cutter. Center, expanding cutter. Right, drill head for tubes plugged solid with deposits.



FLEXIBLE SHAFTING between a motor shaft and the cleaning tool (expanding brush shown above) allows easy negotiation of U-bend tubes.

primary cleaning methods for all tubes because:

- They are adaptable to virtually all heat exchanger designs, including U-bend tubes.
- They are adaptable to all kinds of scale and deposits.
- They have superior cleaning speed when deposits are thick or hard.

Such equipment can be rapidly set up and operated by plant personnel with no special training

or elaborate precautions. All types operate on substantially the same principle: a revolving cutter bit, scraper or brush, power-driven through a tube to break up and dislodge deposits.

Mechanical cleaning tools powered by motors small enough to pass through the tubes are popular for boiler cleaning but aren't the most satisfactory devices for the smaller heat exchanger tubes.

Such motors aren't made for tubes less than $\frac{3}{8}$ -in. O.D. and they don't have sufficient power for rapid production work in the larger heat exchanger tubes, 1 $\frac{1}{2}$ -in. O.D. and above.

The external suspension type of power unit, looking much like an electric drill, is designed especially for heat exchanger tube cleaning. It consists of a high-power air motor operating outside the tube bundle, transferring power through a hollow rotary shaft to which is attached the drill bit, brush, cutter or other accessory.

The motor allows introduction of an air or water scavenger medium that ultimately finds its way through a hollow drill shaft to clear out chips and keep cutters cool.

And . . . What Tools to Pick

Simplest tools used with this type of cleaner are expanding brushes and scrapers. These are composed of cages with cartridges of tufted wire, or with hardened steel scrapers free to move out radially as the cage revolves and thus bear on the inside tube wall.

Brushes are used when deposits are thin and soft; scrapers for gummy or wet deposits that clog brushes. However, some prefer expanding scrapers for all deposits thin enough to remove at a reasonable rate.

For heavy-duty service, with hard and thick scale, three types of cutter bits are used.

An all-around popular type of bit has two flutes with carbide inserts ground to about a 120-deg. cutting angle.

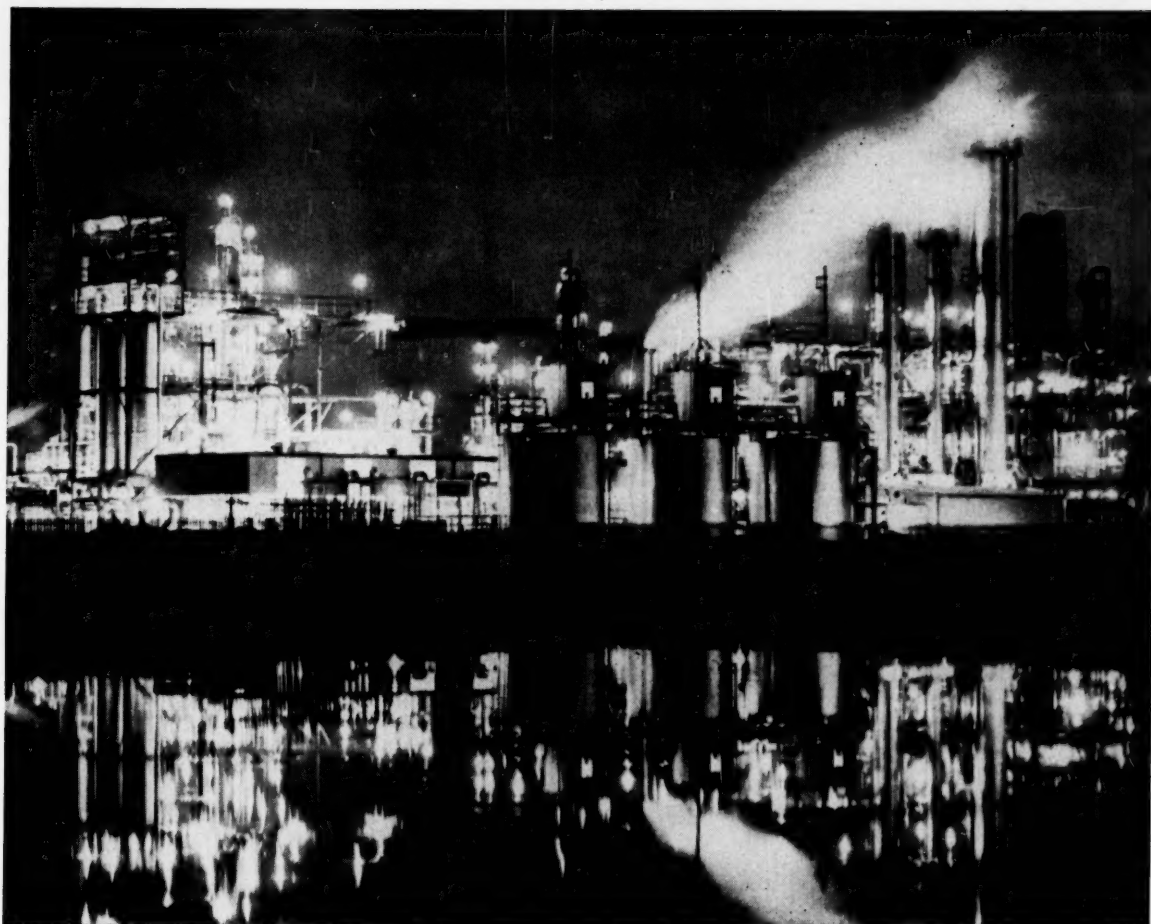
For flint-hard and abrasive deposits, and for plugged tubes, a solid three-flute bit is also used. This has rather stubby edges with reverse rake angles.

A two-lip helix cutter bit faced with carbide is also used for larger tube sizes than the two just mentioned.

Two different types may be furnished by a manufacturer and your experience will usually determine the best choice.

Power Shaft is Hollow

Hollow shaft for power transmission is supplied in various



This electronic computer can help optimize your marketing, production and equipment efficiency!

Royal Precision

LGP-30

World's largest-selling
engineering and scientific
computer



The Royal Precision LGP-30, marketed by Royal McBee, is today helping create new concepts of operating efficiency in many processing industry applications.

The LGP-30 is programmed and operated by the engineer himself to cut through the maze of mathematical computations demanded for peak-level operations. Some examples of the many tasks this machine is now performing are: simple selection of the severity level of the catalytic reformer; most profitable combination of operations in the production, sale and purchase of gasoline, butane, naphtha; computation of heat balances; vapor-liquid equilibria; process simulation; design of heat exchangers, columns and reactors; crude oil evaluation; product yield structure; blending; economic payout determinations.

The LGP-30 is low in cost—about the price of a good engineer—and is simple to program and operate. Its 4096-word memory is comparable to computers many times its size and cost. User-engineers develop a man-machine relationship to the point where the machine becomes an extension of their own thinking capacity. Bolder, more creative engineering almost always results.

No site preparation is necessary. Plug the LGP-30 into the nearest standard outlet and it is ready to go to work. Customers have access to an extensive library of engineering programs and sub-routines, plus the opportunity to join an active users organization.



Royal Precision Corporation

Royal Precision is jointly owned by the Royal McBee and General Precision Equipment Corporations. LGP-30 sales and service are available coast-to-coast, in Canada and abroad through Royal McBee Data Processing offices. For complete information on the LGP-30, write **ROYAL MCBEE CORPORATION**, data processing division, Port Chester, N. Y.

lengths to suit the lengths of tubes encountered. Where headroom or other clearance is limited, short lengths are used and additional short lengths are coupled on as the tool progresses through the tube.

Shafting is normally limber enough in any length to follow the contour of bowed or sagging tubes. Where you encounter U-bends, a flexible shaft is added between the tool and the hollow drill shaft. This allows the tool to go all the way, or at least half way, around almost any bend—even if plugged. In U-bend bundles, general practice is to clean all straight sections first.

The shaft is hollow so a scavenging medium can be supplied through it to flush out pulverized or chipped deposits and keep cutter bits cool.

Air or water are the most commonly used media, the choice often depending on which is most readily available at suitable pressure.

Water has the major advantage of limiting the discharge of dust into the atmosphere. Occasionally, in chemical processing plants, water is unsuitable because it becomes corrosive or otherwise objectionable by dissolving certain deposits.

Steam is sometimes used as a scavenging medium where the

high temperatures may soften deposits and thus aid removal.

Operating air pressure for the drill type of tube cleaning equipment is usually 90 psi., or as available from common 125-psi. plant air lines. However, the equipment often operates satisfactorily on pressures, at the motor, as low as 50 psi.

Scavenger pressure must be high enough to overcome the forward thrust or feed pressure of the cleaner, otherwise the exhaust holes at the bit become clogged. In small tubes, the hollow shaft occupies a substantial portion of the tube cross-section. In light of this, to provide a sufficient volume of scavenging medium, pressure must be quite high. Volume needed depends upon the amount of material removed.

Where deposits are light, pressure as low as 30 psi. is used. For plugged tubes of small diameter, scavenger pressure as high as 125 psi. may be applied. Air pressure is usually 125 psi. since that is the common level of plant air systems.

Where compressed air isn't available, electric-motor-driven cleaners, with tools connected by means of flexible shafting, can be used if deposits aren't too heavy. These cleaners aren't provided with scavenging facilities. Electric cleaners find popular use in the air conditioning and refrigeration fields.

Some Details of the Job

Since downtime is usually a very serious matter with chemical process heat exchangers and since labor costs are high, begin cleaning by making sure everything is ready. This insures no interruptions once cleaning work is actually started.

Unless used recently, give the equipment a complete check. Motors should be cleaned and lubricated. Blow out the hose and inspect it. Sharpen cutters if necessary. Have adequate spares, particularly bits and shafting, on hand.

For safety reasons, insert cutters into the tube before the motor is started. Once the cutter is in the tube, start the motor and advance the cutting tool at a 5-10 ft./min. rate. Keep the cutter in

motion through the tube, forward and backward, while the motor is running.

If possible, don't run the tool all the way out of the far end of the tube. If it is run out, stop the motor and don't start it again until the tool is back in the tube. A good timesaver is to mark the shaft with tape or attach a stop collar when the cutter reaches the end of the first tube.

It isn't essential to run the motor while pulling the tool back through the tube. However, many operators like to do this since it helps complete the scavenging of debris and there may be some remaining residual deposits cleaned out by the powered return trip.

After completing a job, disassemble and clean your tools and coat them with lubricant or rust preventive. Worn tool edges should be sharpened and badly worn parts replaced.

It's important you do this work promptly after finishing a cleaning job. This insures immediate availability of equipment in emergencies.

Devices to Postpone Retubing

A good preventive maintenance program, based on frequent cleaning to prevent excessive accumulations of deposits, prolongs tube life. But eventually, you'll have to replace tubes.

One way to postpone the time for retubing is to plug a few leaky tubes so no liquid can enter them. Plugs are available in various alloys as well as fiber, wood and plastic. They are driven into place with a hammer.

Quite often, the corrosion or erosion responsible for a leaking tube, occurs in the first few inches of the inlet end. These can be restored to service without retubing. Various types of inserts are available which, in effect, provide a new tube wall for the length of the insert. Cementless types, of appropriately coated metal, are simply driven into place. Other types are cemented or rolled in.

Next issue: Rolling & Retubing



AL JOHN is now Assistant General Manager in charge of sales for Thomas C. Wilson, Inc. Since joining them in 1935, Mr. John has served as a tool and product designer, shop foreman, production superintendent, market analyst and salesman. His background in mechanical engineering was acquired at Cooper Union and New York University. Mr. John is a member of ASME and the National Association of Power Engineers.



RELIABILITY...

Because the movement of the stars never varies, an astronomer can determine time to the exact second by checking the position of Leo, Orion, or one of the other constellations that appear in the night skies. That's *reliability* — a word that has become a motto for Mikro-Products. Serving the rapidly growing processing industries, our reputation rides on the performance of the

equipment we manufacture . . . good reason why our standards are high . . . good reason why Mikro grinding, conveying and dust collection units are built to put greater efficiency and economy into our customers' operations. If you'd like to know more about Mikro-Products . . . about Mikro quality and reliability, the information is yours on request, and without obligation.

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PROCESSING SYSTEMS

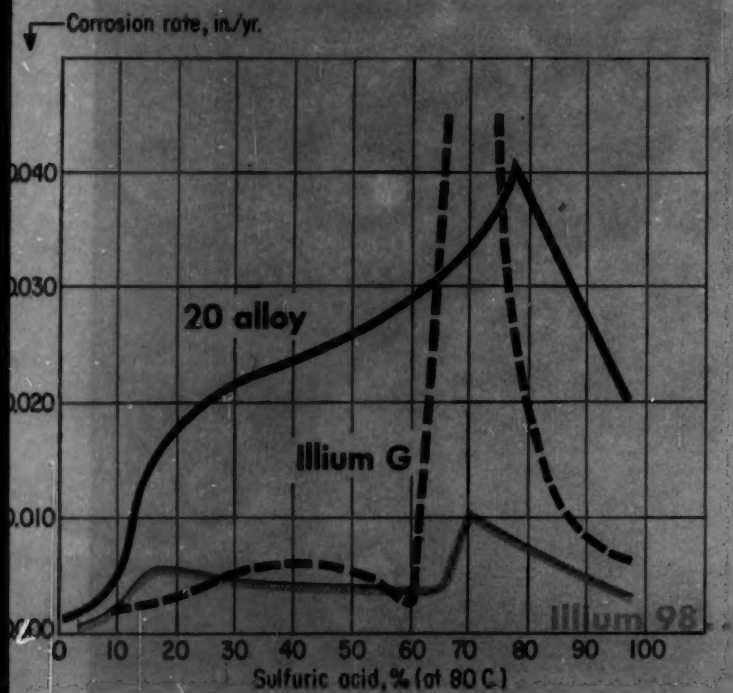


GRINDING CONVEYING COLLECTING

PRACTICE ...

CORROSION FORUM

EDITED BY R. B. NORDEN



... bridges dangerous corrosion gap between 60 and 80% hot sulfuric

New Ni Alloy Cuts Hot Sulfuric Bite

Novel nickel-chromium-copper alloy is the first commercially available material capable of withstanding an entire range of hot sulfuric acid concentrations.

T. E. Johnson, Stainless Foundry & Engineering, Inc., Milwaukee, Wis.

To answer industry's need for a new alloy capable of withstanding hot process acids, we have developed Illium 98.

This machinable, cast alloy with a Ni-Cr-Cu-Mo composition was originally designed to solve contact-sulfuric-acid process problems — particularly 98% sulfuric at elevated temperatures.

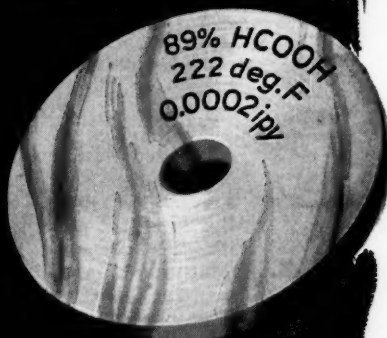
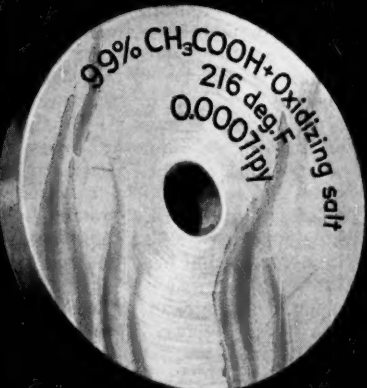
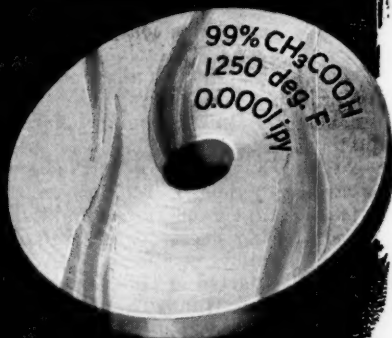
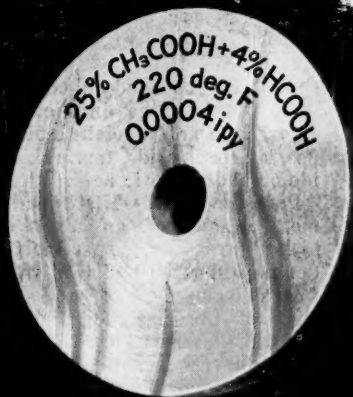
Up until recently, pumps, valves and other components in contact with flowing sulfuric acid seldom had to withstand acid at temperatures above 185 F. Today, many contact plants operate at 230 F. and some at 300 F. have been reported in the literature.

A relatively minor increase in temperature greatly accelerates

sulfuric's corrosion rate, and most standard metals and alloys will not stand up under these elevated temperature conditions.

► **Broad Resistance** — Illium 98 not only shows excellent resistance to strong sulfuric; it also withstands the hot acid over a very wide range of concentrations (see curves above).

For sulfuric, in the difficult 60



Organic Acids Causing Corrosion?

...Test **HAYNES** Alloys

HASTELLOY alloy C and nine other corrosion-resistant alloys were tested in hot acetic acid vapors containing traces of oxidizing contaminants. HASTELLOY alloy C had a penetration rate of only 0.0007 inches per year—lowest among all nine competitive alloys. Others varied from 0.005 to 0.5 inches per year and were severely pitted. This test showed one manufacturer of organic chemicals how he could keep his maintenance costs to a minimum before a process was even on stream.

How much money can you save in your plant? Why not find out for sure by testing HAYNES alloys.

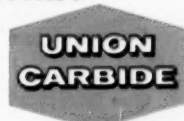
We'll gladly send you samples. There are 6 HAYNES corrosion-resistant alloys. To help us select the one most likely to solve your problem, we suggest that you send us a letter outlining the corrosive conditions in your plant. To learn more about HASTELLOY alloys, ask for a copy of our 104-page book. It describes the alloys in detail.

HAYNES

ALLOYS

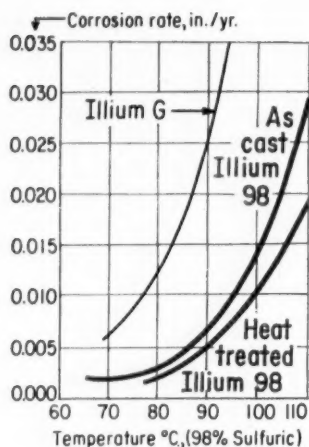
HAYNES STELLITE COMPANY

Division of
Union Carbide Corporation
Kokomo, Indiana



The terms "Haynes," "Hastelloy," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

New Alloy Shows Good Resistance to 98% Sulfuric



to 90% range, Illium 98 is much superior to Stainless 20 alloy up to about 80 C. and is also superior to our well-established Illium G. However, the 98 alloy is attacked by sulfuric above 80 C. in the 60 to 90% range (we usually consider a metal questionable if it has a corrosion rate above 0.02 in./yr.).

In addition the alloy shows very good resistance to nonhalogen acids.

► **Good Properties** — Nominal composition of the new alloy is as follows: 55% nickel, 28% chromium, 8.5% molybdenum, 5.5% copper, 1.25% manganese, 1.0% iron and 0.05% carbon (see table below).

Copper is essential for good sulfuric acid resistance; nickel keeps all the copper in solution. The roles of chromium, molybdenum and manganese in resistant alloys are well known.

Mechanical properties are: 54,000 psi. tensile strength; 18% elongation in 2-in.; 22% reduction in area and 152-167 Brinell hardness.

Illium 98 is readily machinable using techniques standard for stainless steels (carbide tooling and rigid, adequately powered machines).

It is also weldable by arc, inert-arc or acetylene techniques. Welding rods are available.

Costs will be 1½ to 2 times Stainless 20, or about 10% more than Illium G.

Promising applications appear to be in pumps, valves, and fittings for sulfuric service, and in contact with moist SO₂ gas, waste sulfite liquors and in alkylation or sulfonation equipment.

► **And Bad**—But, before going any further, remember Illium 98

should not be used in contact with wet bromine and iodine, chloracetic acid, moist chlorine gas, cupric chloride, ferric chloride or hydrochloric acid.

► **Parr Developed**—Historically, modifications of an alloy of nickel, chromium, copper, molybdenum, tungsten and iron were first disclosed by Professor Parr of University of Illinois, in U. S. Patent 1,115,239. Such alloys have been standard materials of construction for precision process parts (use has been confined largely to pump and valve components).

As exclusive producers of high-nickel alloy castings sold under the Illium trademark, Stainless Foundry & Engineering metallurgical personnel have observed the trend to higher operating temperatures in contact plants and the resulting decrease in service life of alloy components. Work was started in 1948 towards improving Illium G, used extensively in the industry.

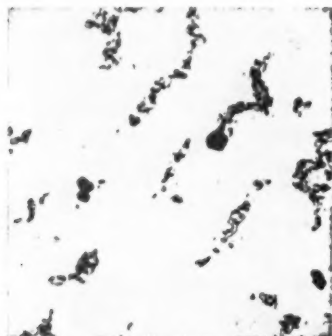
► **Intergranular Attack** — Preliminary examination of alloy pump impellers removed from plant service after corrosion failure showed the corrosion process was an intergranular type attack of a secondary phase of the alloy. This second phase was present as a cell structured eutectic network. So original efforts to minimize corrosion in hot, concentrated sulfuric acid involved special heat treating to interrupt continuity of this phase. Photograph on the left shows the normal structure of the Illium G alloy and the manner in which the second phase is attacked by hot, conc. H₂SO₄.

A special two-stage heat treatment was developed to produce a more homogeneous structure.

The heat-treated alloy exhibited little or no improvement over the cast alloy in laboratory corrosion tests measured in terms of weight loss. But in actual plant tests, pump impeller life was more than doubled. This added life was principally due to a reduction in intergranular corrosion.

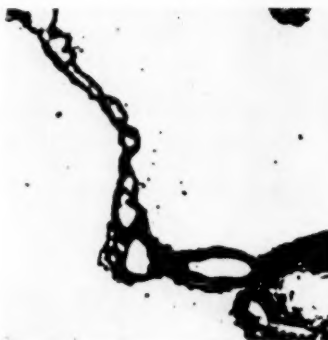
► **Structure Change**—Therefore, special heat treating of Illium G was only a partial answer to the basic problem. Effort was

Homogeneous Structure



Illium 98

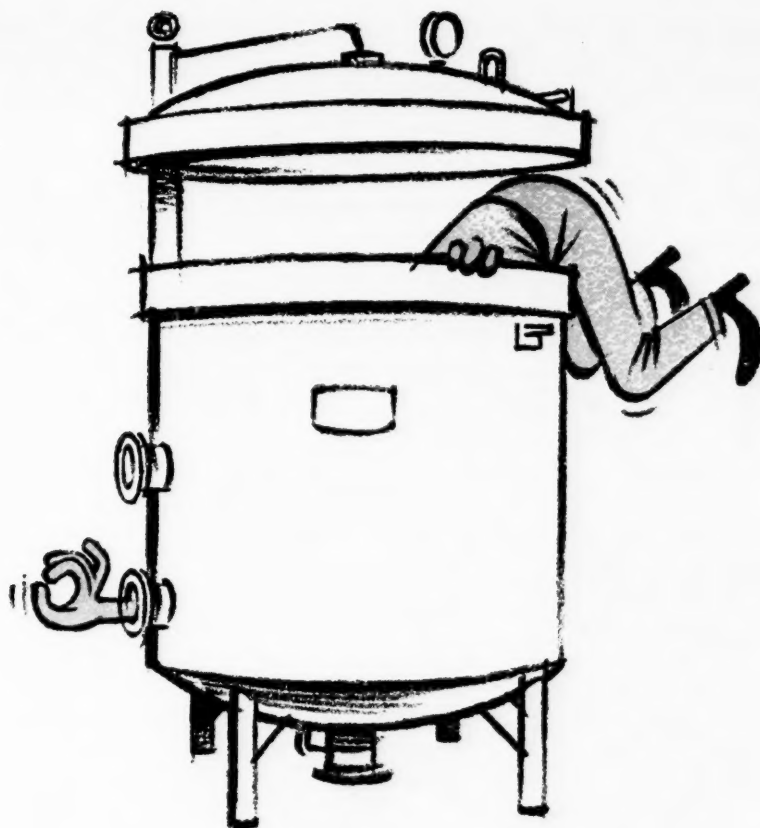
Prevents Acid Penetration



Illium G

Composition Change Increases Sulfuric Resistance

	Ni	Cr	Mo	Fe	Cu	Mn	Si	C
Illium G.....	56%	22.5	6.4	6.5	6.5	1.25	0.65	0.20
Stainless 20.....	28	20	2.5	Bal.	4.0	6.75	0.65	0.08
Illium 98.....	55	28	8.5	1.0	5.5	1.25	0.70	0.50



A FILTER WORTH LOOKING INTO

You have to look "under the hood" of a Durco-Enzinger filter to really appreciate some of the engineering and design advantages that you get. For example, are you familiar with these **exclusive** Durco-Enzinger features and how they can help you solve your filtration problems?

- Finger leaf spacers
- Wingwheel closure
- Tilting leaves
- Oscillating sluice
- Traveling sluice
- Cake thickness detector

Couple all these with a good basic pressure leaf filter design, ASME code construction, rugged leaves and real filtration know-how, and you surely have a filter worth looking to. Write for bulletin EF/2a.



ENZINGER DIVISION

THE DURIRON COMPANY, INC., Dayton, Ohio / Filters • Valves • Pumps • Process Equipment

then centered on the problem of changing the structure of the alloy to eliminate the second phase, if possible.

During this investigation numerous alloy combinations were made and their structures observed microscopically. Alloys exhibiting promising structures

were subjected to laboratory corrosion tests in hot, concentrated sulfuric acid. Correlation of analytical, corrosion rate and metallographic data was made and from the trends observed a new alloy was evolved which showed marked improvement over all other al-

loys tested. This is called Illium 98 because of its original intended use in hot, 98% sulfuric acid. Subsequent tests have shown it to have utility over the entire range of sulfuric acid concentrations.

The picture on p. 196 shows a typical metallurgical structure of the 98 alloy. Grain boundary precipitation and coring of the alloy-rich matrix is eliminated by heat treatment as shown.

► **Lab Tested** — A substantial improvement in corrosion resistance in sulfuric acid media is shown in laboratory tests made on specimens of three commercial heats. Field test observations, although yet limited in number, so far have confirmed the experimental corrosion values.

The curves show nominal corrosion rate data for Illium G and Stainless 20 alloys as compared with rates tabulated for Illium 98 at 80 C.

Also note the curves showing improved performance of the alloy in hot, 98% sulfuric acid.

Many varied factors entered in the final adoption of the new alloy. Naturally, resistance to sulfuric acid was of primary importance. It was also desirable not to employ alloy additions that would interfere with the alloy's excellent resistance to nitric acid and other oxidizing media. Silicon and copper were retained at nominal levels to minimize attack of traces of chlorides and fluorides when present in sulfuric acid.

Thus a new and interesting corrosion-resistant alloy is made available to the chemical process industry in the form of quality sand castings.



Light Wall Stainless Replaces Plastic Pipe

Here's a reverse twist, away from plastic back to metal. American Synthetic Rubber Corp., Louisville, Ky., has thrown out plastic-lined piping, serving two 7,000-gal. cypress holding tanks containing concentrated alum, because of service failures. The replacement: light-wall stainless handling alum at 5 to 10 psi. and 120 F. Pipe is 5S and 10S in 1½ and 2-in. sizes. (Tube Turns).

Another installation at American Synthetic of light-wall pipe carries fatty acids at about 50 psi. and 130 F. This serves two 15,000-gal. resin-lined holding tanks where fatty acid is brought in by over-the-road tankers.

From there it is piped to metering stations and then to three 10,000-gal. make-up tanks. Relatively low pressures make it unnecessary to use standard-weight pipe.

An American Synthetic representative says use of lighter-than-standard-weight pipe and fittings reduces initial cost of materials substantially. He estimates light weight and ease of handling has reduced cost of installation about 20%. Light-wall material costs about one-third less, weighs about one-half as much, and provides greater flow area than the same nominal pipe size in standard weight (Schedule 40S).

THOMAS E. JOHNSON is chief metallurgist at Stainless Foundry and Engineering, Inc. He is a graduate of the Michigan College of Mining and Technology (BS in ChE). He became interested in alloy development while working as a laboratory assistant to the late Dr. Burgess of Burgess battery fame. Mr. Johnson has worked in the field of alloy development since 1943 and during that period was connected with the Burgess-Parr Co. and Fairbanks, Morse & Co. before joining Stainless Foundry.



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PILOT PIPE

When
you need
a real
twister

"U.S." "straight-through"
pipe requires no flanges.
Simply cut to size, slip
over pipe and clamp on.

...Get U.S. Pilot Pipe!

This limber, highly abrasive-resistant U. S. Pilot® Pipe is at work 7 days a week, 24 hours a day (during the 6-month concentrating season) in the heavy media department of the beneficiation plant of a large iron ore producer. It carries 200 gallons per minute of ferro silicon into a magnetic separator.

BIG REASONS WHY U. S. PILOT PIPE IS USED:

- Company records show that U. S. Pilot Pipe lasts about 12 times longer than metal pipe.
- Maintenance is nil.
- Pilot Pipe is so flexible it permits an easily formed angle,

eliminating need for elbows (the smooth flow reduces points of turbulence) hence it takes up less room, requires less plumbing.

U. S. Pilot Pipe includes a wide range of designs ("straight-through", duck and rubber flanges, swivel flanges) that handle a wide range of working pressures—from 25 to 250 pounds—and also handle a wide range of chemicals and abrasives.

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.



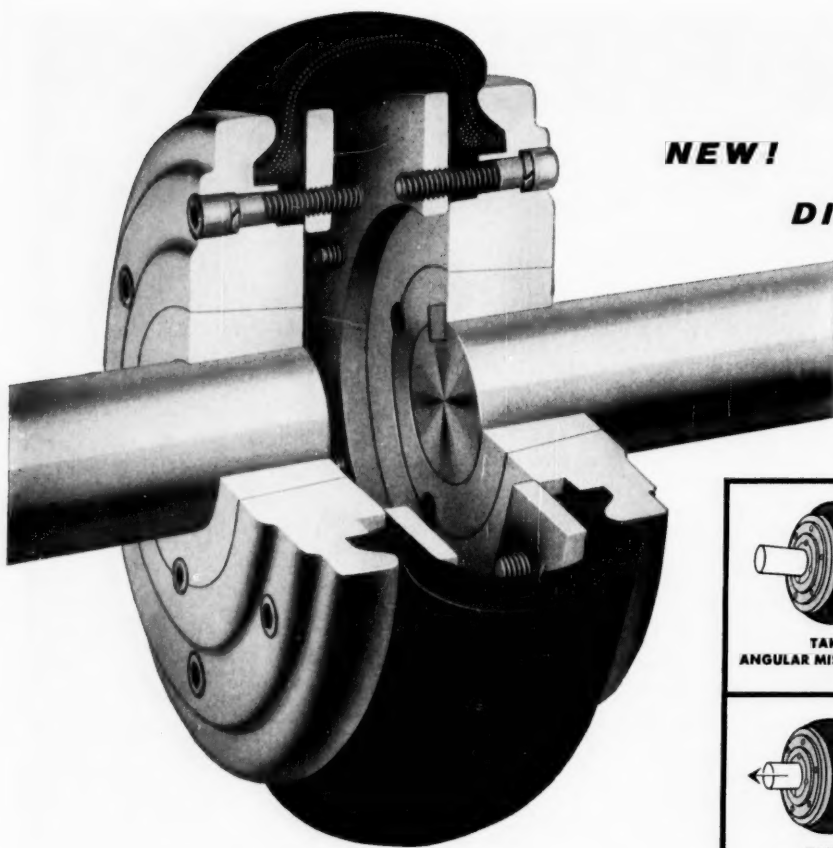
Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

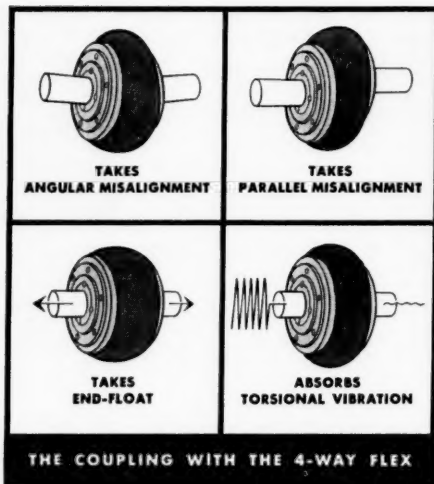
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DIFFERENT!



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Para-flex

FLEXIBLE CUSHION COUPLING

THIS coupling "swallows up" shaft misplacements. It automatically compensates for end-float, parallel misalignment, angular misalignment or *any combination of all three*. Moreover, it cushions the stresses of shock loads. And it absorbs torsional vibration—reducing noise and protecting machinery from vibration's destructive forces.

Here is a new type of performance—made possible by the development of a tire-like flexing element. Synthetic tension members, bonded together in rubber, give this element the stamina and dependability of modern, high-speed, high-load, shock-absorbing truck tires—and the ability to respond magically to all manner of changing shaft conditions.

Para-flex takes minimum space on the shaft. Mounting is simplified through the use of standard Taper-Lock bushings—no reboring, no machining. Safety is promoted by flush design; there are no protruding

parts. No lubrication is required, no periodic inspection. And since the flexible member is molded with a transverse split, it can be replaced *without moving either the driver or driven machine*.

Para-flex Couplings are stocked by Dodge Distributors in popular transmission sizes. They are available from factory stock in capacities up to 2000 hp at 1080 rpm. Call your distributor for a coupling to *make your own test*. You'll witness something revolutionary!

DODGE MANUFACTURING CORPORATION, 200 Union, Mishawaka, Ind.



DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the white pages of your telephone directory for "Dodge Transmissioneer."

FIRMS IN THE NEWS

J. A. KING

NEW FACILITIES



Lion Oil's Propylene Tetramer Unit Goes On Stream

Monsanto Chemical Co. has just placed on stream new propylene tetramer capacity at its Lion Oil Division in El Dorado, Ark. Lion now ships tetramer intermediate to Monsanto's Inorganic Division in Monsanto, Ill., where synthetic detergents are produced.

Tetramer unit is first step in Lion's broad expansion and modernization program. Plans include production of other petroleum-derived chemical intermediates for Monsanto. And recent installation of 5,000-bbl./day catalytic reformer, hydrodesulfurization and solvent deasphalting units, modernizes petroleum refining at El Dorado.

Ashland Oil & Refining Co., Ashland, Ky., announces plans for construction of the first hydroalkylation plant for production of benzene and naphthalene from petroleum. New plant, with capacity to produce a maximum of either 12-million gal./yr. of benzene or 25,000 tons/yr. of naphtha-

lene, will be located at Ashland's Buffalo, N. Y., refinery.

Anderson Chemical Co., div. of Stauffer Chemical Co., has brought on stream commercial-scale capacity for production of vanadium oxytrichloride. Plant output will be marketed as an intermediate for manufacture of olefin-polymerization catalyst.

Fluor Corp. will perform engineering, equipment procurement and construction of a 450-million-cu.-ft./day natural gasoline plant for Union Oil Co. of Calif. and Goliad Corp. of Houston, Tex. Plant, to cost more than \$4-million, will be located at Vermillion Parish, La., will consist of distillation, refrigeration, glycol and sponge oil units, as well as power and steam generation facilities.

Cyanamid of Canada, Ltd. has placed on stream its new urea

DODGE
PRODUCTS
you
should
know

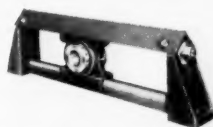


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with **TIMKEN BEARINGS**
America's Quality Pillow Blocks!



TAPER-LOCK STEEL
CONVEYOR PULLEYS

Maximum strength with minimum weight!



DODGE TAKE-UPS

Complete range of stock models, sizes.

Write for Bulletins!

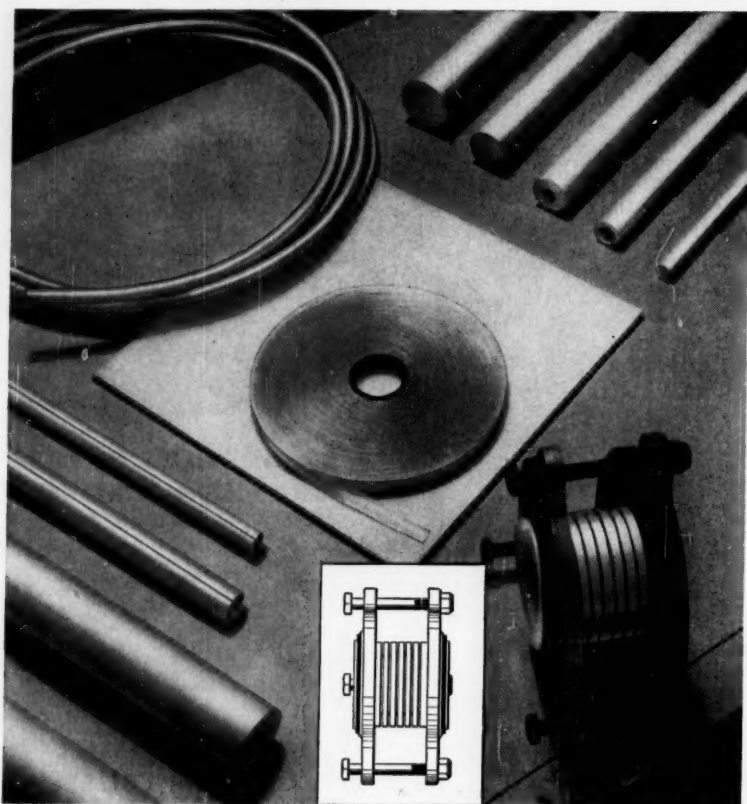
- ✓ Rolling Bearings—ratings, data.
- ✓ Conveyor Pulleys—technical data.
- ✓ Take-Ups—Roller, Ball, Babbitted.

DODGE MANUFACTURING CORPORATION
200 Union Street • Mishawaka, Indiana

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LOOK TO R/M TO MEET ALL YOUR TEFLON* NEEDS



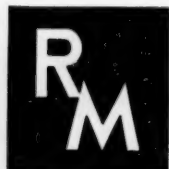
R/M—headquarters for "Teflon" products. R/M's complete line includes sheets, rods, tubes, tape, thin-wall tubing (available with permanent color striping) and bondable "Teflon." New "Teflon" expansion joint features square convolutions for greater strength. Other "Teflon" parts, extruded, molded or machined to your exact specifications, can also be supplied.

"Teflon's" many remarkable properties have established it as an important material for use in chemical processing equipment. Yet when you select "Teflon" for a particular job, you solve only part of your problem. Equally important is the selection of a source of supply you can depend on for both competent engineering assistance and the production capability needed to meet your exact specifications and quantity requirements. This complete

"Teflon" service is yours from R/M.

A pioneer in "Teflon" application and fabrication research, R/M offers design guidance that can help assure maximum part performance, and its ample production facilities can supply "Teflon" in the form best suited to your needs. Learn more about R/M's complete "Teflon" service—and how it can benefit you—by contacting your nearest R/M district office. Or write Plastic Products Division, Manheim, Pa.

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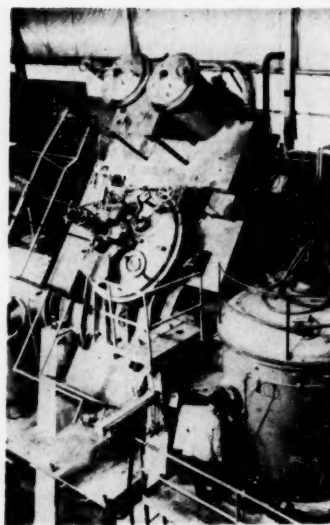
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Brake Blocks • Clutch Facings • Laundry Pads and Covers • Industrial Adhesives • Bowling Balls

FIRMS . . .

plant at Hamilton, Ont. New facility, with a rated capacity of 66,000 tons/yr. of urea, employs the Chemico process (*Chem. Eng.*, Jan. 26, 1959, p. 48-50).



Kelsey-Hayes Co. of New Hartford, N. Y., has installed this giant high-vacuum induction furnace at its Metals Division plant. New furnace with 5,000-lb. capacity has an interesting new feature; the entire melting chamber tilts to pour the vacuum-melted and purified metal. Prevailing crucible tilting within the vacuum chamber, that limited furnace size, is thus eliminated.

U. S. Atomic Energy Commission will begin construction of a ninth production reactor at the Hanford Works near Richland, Wash. Kaiser Engineers, prime contractor on the \$145-million job, began calling for bids last month, are now calling for bids on water filtration and demineralization plants.

Phillips Petroleum Co. announces plans for construction of a 25,000-bbl./day catalytic cracking unit at its Borger, Tex., refinery. Addition of new unit increases Borger refinery's cracking capacity to 65,000-bbl./day. Construction by M. W. Kel-



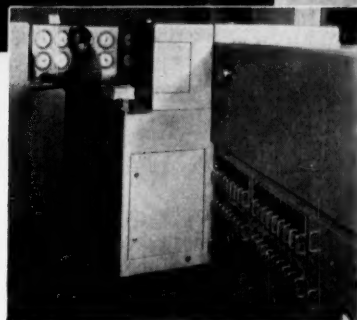
General view of the wet laboratory

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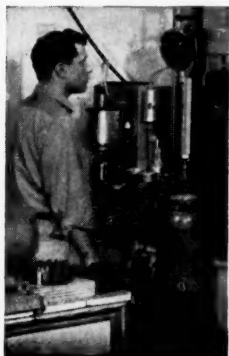
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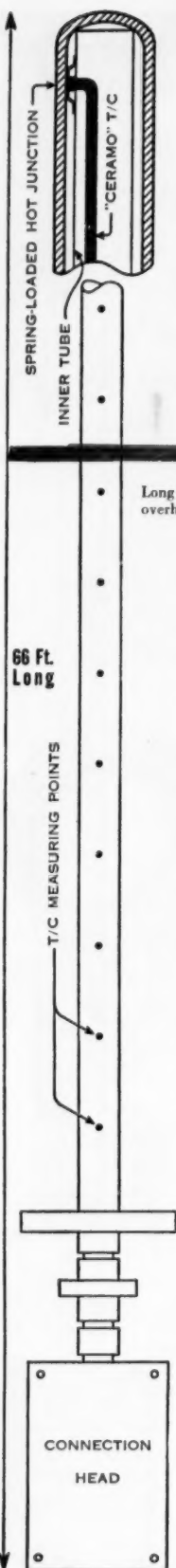
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Thermo Electric makes thermocouples for just about every possible application—including some pretty unusual ones. The multi-thermocouple assembly diagrammed here is a good example. It's 66 feet long.

The longest of three, this assembly has a total immersion length of 63'7". The entire unit actually contains 12 different thermocouples—in progressively longer lengths from 9'1" to 63'7". These are enclosed in a 1½" I.P.S., Schedule 80 protection tube of type 304 Stainless Steel. Individual thermocouple construction is of T-E's "Ceramo"—ceramic insulated conductors encased in overall metal sheathing. O.D.'s are ½" with 22 gage Iron-Constantan conductors. Hot junctions are welded closed and, for fast response, are spring-loaded against the inner wall of the protection tube.

The three assemblies were sent by T-E to Durban, South Africa for installation in a catalyst reactor. They are typical of what Thermo Electric is currently doing in the field of temperature measurement. T-E equipment is being used all over the world for important temperature measuring jobs. Assemblies like this, used in deep vessels, will measure temperatures at any desired level. Thermo Electric also makes miniature thermocouples as small as ½" immersion length. Whatever your needs, for large or small thermocouples, for low or extremely high temperatures, for any type of application, contact Thermo Electric. Our extensive research, engineering and manufacturing facilities are at your disposal.

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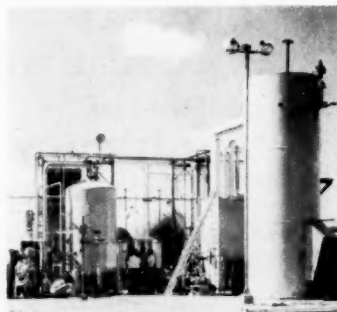


In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

FIRMS . . .

logg Co., New York, will begin early next year, is scheduled for completion by early-1961.

Olin Mathieson Corp. will expand electrolytic chlorine-caustic capacity at its Chemicals Division plant in McIntosh, Ala. Expansion will consist of addition of a new cell bank to the two already in operation.



Linde Co., a div. of Union Carbide Corp., has placed on stream the first liquid-hydrogen plant in the northeastern U.S. New unit, shown above is located in Tonawanda, N. Y., can produce more than 25,000 1./month of liquid product with a minimum of 95% parahydrogen content. Pilot studies at Tonawanda will be basis for design of a production-scale unit for Torrance, Calif.



Dow Chemical Co. announces a new domestic division and a new foreign acquisition. On the domestic scene, the Industrial Service Division now markets the services of the former Dowell Division, plus new industrial waste-treatment services. On the foreign scene, Dow Chemie A. G. and Rio Tinto Co., Ltd., of London, England, have acquired Thorium, Ltd., of England. Latter

company produces cerium and thorium compounds for industrial use.

Smith Kline & French Laboratories announces the purchase of Norden Laboratories of Lincoln, Neb. SK & F thus plans to expand its line of pharmaceutical products to add a new line of veterinarian pharmaceuticals and biologicals.

Cary Chemicals, Inc., Flemington, N. J., has formed Regency Plastics, Inc., to produce and market vinyl and polyethylene film. Another Cary subsidiary, Great Bay Plastics & Chemical Co. will produce vinyl film for final finishing by Regency.

Vitro Engineering Co. has merged with The Refinery Engineering Co. (TRECO) of Tulsa, Okla. to form the TRECO Construction Division of Vitro Engineering Co. Merger will enable Vitro Engineering Co. to offer both design and construction services.



OVERSEAS BRIEFS

France: Pechiney and Saint-Gobain are forming a new company, to market chemical, fertilizer and plastics products, produced by both firms. Joining of sales forces is a trend in European chemical industry; recently Inatom, Resines Fluoes, Produits De Titane, Aquitainechimie, Methaolacq and Azolacq joined their forces.

India: World's largest urea plant, with a 500-ton/day capacity, will be constructed at Neyveli on the Indian peninsula, about 140 mi. from Madras. Italy's Montecatini and Ansaldo and India's Neyveli Lignite Corp. Private, Ltd., have signed a \$21-mil-

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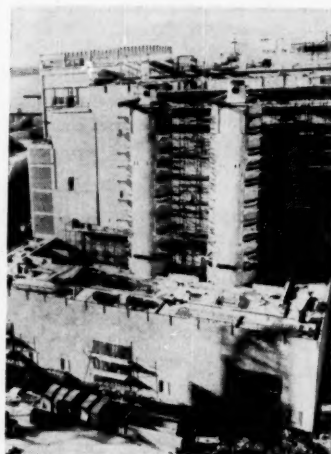


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FIRMS . . .

lion-dollar prime contract for the job. Montecatini will design and construct the urea plant, to employ the Fauser-Montecatini process (*Chem. Eng.*, Jan. 26, 1959, pp. 45-46). German Linde will provide air-distillation nitrogen capacity, while Pintsch-Bamag will provide lignite drying and gasification equipment. Entire facility, to be completed by early 1963, will cost about \$52.5-million.



England: Bradwell Nuclear Power Station, now under construction, is now nearing completion. Precursed by the Calder Hall Station, this 300-mw. reactor is gas-cooled; shown above are two of twelve giant heat exchangers to generate steam for the generator turbines.

Germany: A new polyethylene and caprolactam plant at Leuna is now under construction, adjoining the former I. G. Farben plant. Plant, to be completed by 1965, will employ some 1,300 operators and engineers, will produce some \$100-million worth of product annually.

Rumania: AGERPRESS, newest division of the Turda Chemical Combine, has just placed on stream Rumania's first polyvinylchloride plant. New plant has a 5,500-ton/yr. capacity, was designed and constructed by Rumanian engineers.

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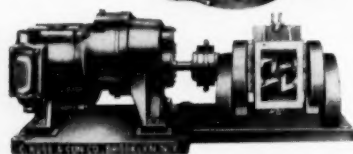
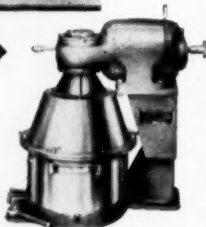
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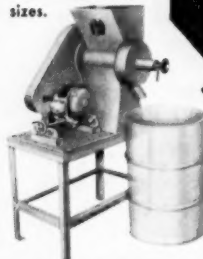
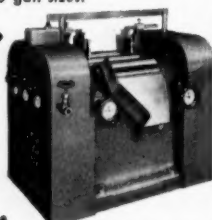
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CALENDAR

The Material Handling Institute, annual meeting, Savoy-Hilton Hotel.

Dec. 13-16 New York, N. Y.

American Statistical Assn., annual meeting, Shoreham Hotel.

Dec. 27-30 Washington, D. C.

American Chemical Society, Div. of Industrial and Engineering Chemistry, Christmas Symposium.

Dec. 28-29 Baltimore, Md.

Society of Plastics Engineers, annual technical conference, Conrad Hilton Hotel.

Jan. 12-15 Chicago, Ill.

Engineers Joint Council, annual meeting, Engineering Building.

Jan. 22 New York, N. Y.

Plant Maintenance and Engineering Show, Convention Hall.

Jan. 25-28 Philadelphia, Pa.

American Society for Engineering Education, college-industry conference, Washington University.

Jan. 27-28 St. Louis, Mo.

American Physical Society, annual meeting, Hotel New Yorker.

Jan. 27-30 New York, N. Y.

American Rocket Society, Solids propellants Conference, Princeton University.

Jan. 28-29 Princeton, N. J.

American Institute of Electrical Engineers, national meeting.

Jan. 31-Feb. 5 New York, N. Y.

Instrument Society of America, Instrument and Automation Conference and Exhibit, Sam Houston Coliseum.

Feb. 1-5 Houston, Tex.

American Society for Testing Materials, committee week, Sherman Hotel.

Feb. 1-5 Chicago, Ill.

Society of the Plastics Industry, Reinforced Plastics Div. meeting, Edgewater Beach Hotel.

Feb. 2-4 Chicago, Ill.

Western Industrial Isotopes Conference, cosponsored by Stanford Research Institute and the University of California, for program contact Conferences Dept., Berkeley campus.

Feb. 3-5 Menlo Park, Calif.

American Society for Metals, metals conference, Fairmont Hotel.

Feb. 4-6 San Francisco, Calif.

American Institute of Mining, Metallurgical and Petroleum Engineers, annual meeting, Statler McAlpin Hotel.

Feb. 14-18 New York, N. Y.

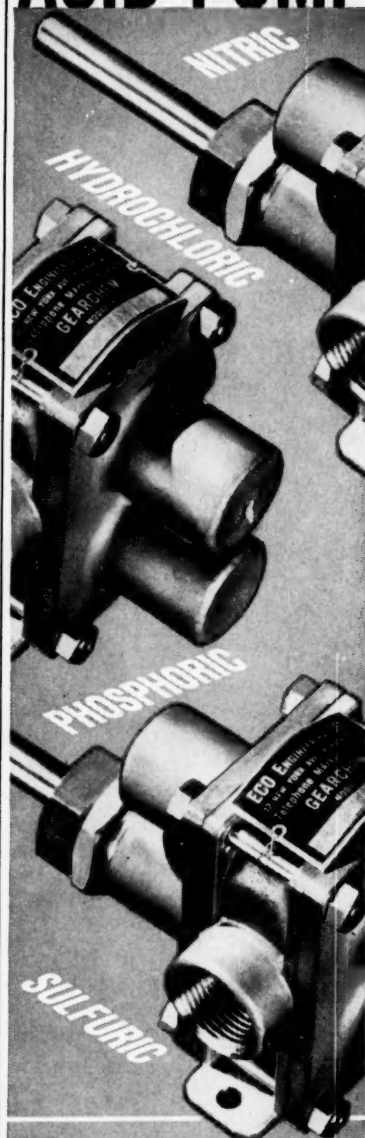
The Australasian Institute of Mining & Metallurgy, Symposium on Hydrometallurgy, S. Australian Dept. of Mines.

Feb. 16-19 Thebarton, Australia

National Society of Professional Engineers, winter meeting, Broadview Hotel.

Feb. 18-20 Wichita, Kan.

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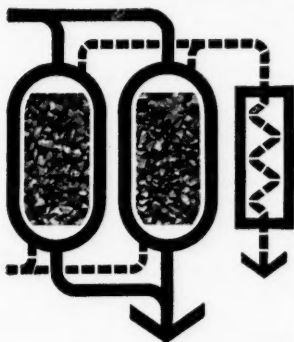
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American Institute of Chemical Engineers, national meeting, Biltmore Hotel.
Feb. 21-24 Atlanta, Ga.

Technical Assn. of the Pulp and Paper Industry, annual meeting, Commodore Hotel.
Feb. 22-25 New York, N. Y.

Natural Gas Engineering Conference, Oklahoma State University.
Feb. 23-25 Stillwater, Okla.

Pittsburgh Conference on Analytical Chemistry and Spectroscopy, Penn-Sheraton Hotel.
Feb. 29-Mar. 4 Pittsburgh, Pa.

American Society of Mechanical Engineers, Gas Turbine Power conference and exhibit, Rice Hotel.
Mar. 6-9 Houston, Tex.

American Society of Mechanical Engineers, Hydraulic Conference, Rice Hotel.
Mar. 6-9 Houston, Tex.

Instrument Society of America, Temperature Symposium, Deshler-Hilton Hotel.
Mar. 9-11 Columbus, Ohio

The Fiber Society, spring meeting, Roosevelt Hotel.
Mar. 10-11 New Orleans, La.

American Concrete Institute, annual convention, Commodore Hotel.
Mar. 14-17 New York, N. Y.

National Assn. of Corrosion Engineers, 16th annual meeting, Memorial Auditorium.
Mar. 14-18 Dallas, Tex.

Institute of Radio Engineers, national convention, Waldorf Astoria Hotel & New York Coliseum.
Mar. 21-24 New York, N. Y.

Oil Trades Assn. of New York, meeting, Waldorf Astoria.
Mar. 23 New York, N. Y.

New England Gas Assn., annual meeting, Statler-Hilton Hotel.
Mar. 24-25 New York, N. Y.

Textile Research Institute, annual meeting, Hotel Commodore.
Mar. 24-25 New York, N. Y.

American Oil Chemists Society, meeting, Baker Hotel.
April 3-6 Dallas, Tex.

Nuclear Congress, sponsored by Engineer's Joint Council and Engineering and Scientific societies, New York Coliseum.
April 3-8 New York, N. Y.

Instrument Society of America, National Chemical and Petroleum Symposium.
April 5-7 Rochester, N. Y.

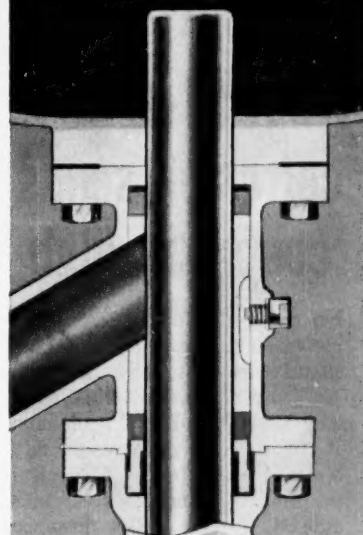
American Society of Mechanical Engineers-Institute of Radio Engineers-American Institute of Electrical Engineers, third annual conference on Automatic Techniques, Cleveland-Sheraton Hotel.
April 18-19 Cleveland, Ohio

American Society of Lubrication Engineers, annual meeting and exhibit, Netherland-Hilton Hotel.
April 19-21 Cincinnati, Ohio

American Society of Mechanical Engineers-Society for Advancement of Management, Management conference, Statler-Hilton Hotel.
April 21-22 New York, N. Y.

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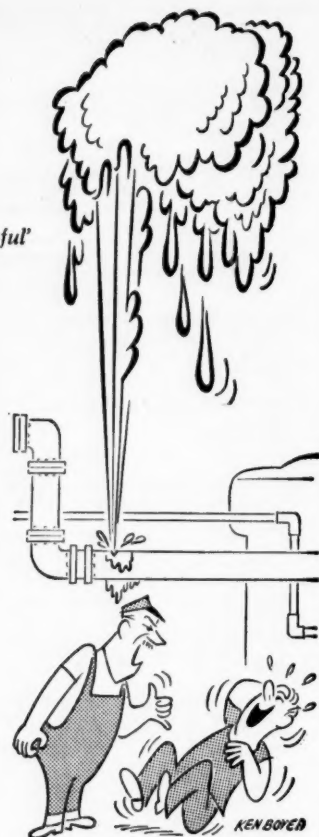
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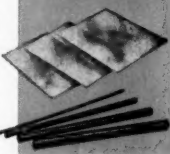
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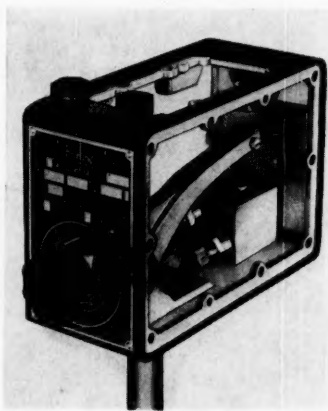
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NEW EQUIPMENT ...

(Continued from p. 111)

cost is \$1,600/mo.; selling price is listed as \$74,500.—IBM, Data Processing Div., White Plains, N. Y. 111D



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Output air pressure proportional to temperature.

Model OA, a differential expansion-type temperature controller, provides air pressure proportional to temperature, and is useful for direct operation of air-operated process equipment. Maximum operating temperature is 2,000 F.

Required supply-air pressure is 50 psig., connected to the inlet at the top. The air system includes a rugged, accurate pilot valve of the bleed type. Cast aluminum housing, which is weathertight, permits application at outdoor locations.—Burling Instrument Co., Chatham, N. J. 210A

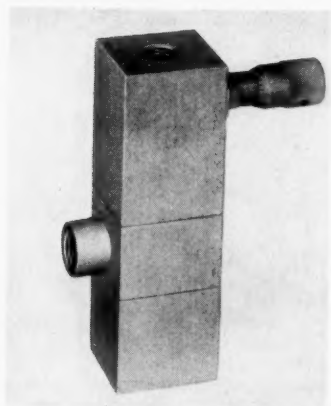
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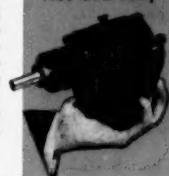
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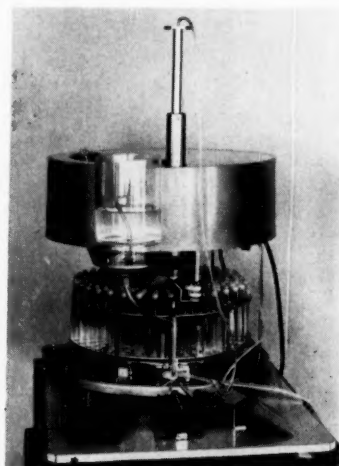
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tests on full-scale units indicate that gas absorption efficiencies run from 45 to 50%.

Consisting mainly of a multi-blade rotor connected to the submerged end of a hollow shaft mounted within a draft tube, the Cavitator operates in both closed and open systems, in either continuous or batch processes. Blowers, compressors, spargers and similar auxiliary equipment are not necessary. Tank sizes run to 23,000 gal.—**Yeomans Bros. Co., Melrose Park, Ill. 211B**



Automatic Sampler

Analytical accessory automates sample handling.

One function of the new Auto-Sampler is automatic transfer to and from the measurement cell of a spectrophotometer, polarimeter, refractometer or other analytical instrument. Another is collection of samples from a source, such as a sample line, chromatographic column, fractionating column, etc.

Auto-Sampler can sample or collect up to 144 test tubes of fluid. The tubes come equipped with polyethylene ball caps, which can be removed and replaced automatically whenever samples are withdrawn or placed into the tubes.

In operation, samples are transferred in sequence to the instrument cell for measurement. After measurement, each sample is returned to its origi-

U.S.I. CHEMICAL NEWS

Dec.

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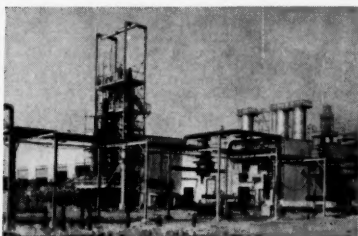
1959

Polyethylene Expansion To 300 Million Pounds Planned by U.S.I.

U.S.I. has recently announced plans for a new increase in production capacity of PETROTHENE® polyethylene resins at its Houston plant—this time 50 million pounds. This will bring total company capacity to 300 million pounds per year.

The Houston plant, opened just this past March, is already being upped from 75 to 150 million pounds and, with this new expansion, will reach a capacity of 200 million pounds annually. At its other plant in Tuscola, Illinois, the company is producing polyethylene at the yearly rate of 100 million pounds.

The new expansion, expected to be complete by mid-1960, will make U.S.I., with a capacity of 300 million pounds, the second largest polyethylene producer in the world.



Gas producing area at U.S.I.'s Houston plant.

New Inorganic Polymer Has Been Made from Zinc, Chlorine and Ammonia

Researchers have recently reported the development of a new polymer containing only zinc, chlorine and ammonia—which appears to have limited elastomeric properties. The development is significant since plastics and rubber-like materials are made for the most part from organic polymers. In general, inorganic substances do not form polymers, and cannot be produced in rubbery form.

Inorganic polymers are being investigated because many inorganics resist higher temperatures than do organics, and present operating temperatures for many devices are at about the limit that organic polymers can stand. Inorganic polymers might permit raising operating temperature limits.

The new material is called a polymeric monoaminedichlorozinc, and its thermal and hydrolytic stability are said to leave much to be desired. Consequently, the research group plans to make and evaluate a large number of such compounds, in the search for the specific properties of thermal stability and elastomeric nature desired.

The new product is described as an amber-colored, transparent, glassy material at room temperature. It softens on heating and becomes a heavy syrup at about the boiling point of water. When just molten, it can be drawn into fine filaments which are reported to exhibit plasticity and flexibility after cooling. Films of the polymer are said to adhere well to aluminum and glass surfaces.

Complete Details on Sodium- Handling Equipment Presented In New U.S.I. Brochure

Third Edition of Comprehensive Sodium Handling
Book Contains Much New Data, Presents Latest
Information on All Phases of Handling Technology

The third edition of U.S.I.'s brochure, "Handling Metallic Sodium on a Plant Scale", edited by U.S.I.'s experienced technical service engineers, is just off the press.

Research Elders Form Non- Profit Consulting Group

A novel kind of association has been formed under the name Technically Experienced Associates, Mobilized, or "TEAM, Inc." Members are retired research executives of some of the largest industrial companies in the country. They have formed this association to make their wide research experience available "for the benefit of mankind, without entering into competition with commercial consulting organizations or individuals."

"TEAM" members offer their services in these general research and advisory fields: research management, national defense, scientific and technical education, public health, conservation of human and natural resources, and scientific matters of national and international interest.

In keeping with the purposes and objectives of the organization, "TEAM" members offer their services at cost plus a small overhead to cover office expenses. The association says it will welcome as additional members retired research executives from broad fields of professional and scientific activity.

This brochure has been an authoritative source of information since the first edition was published in 1951, shortly after U.S.I. first opened its sodium plant at Ashtabula, Ohio.

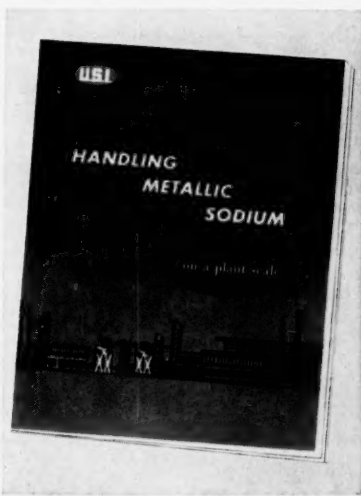
Revised and greatly expanded, the new edition contains the latest information on metallic sodium and its uses, sodium-handling equipment, procedures for handling sodium in the plant, and general safety and first aid measures. The list of references has been brought up-to-date.

Equipment Section Is Comprehensive

The equipment section in particular has been enlarged and is now more than two times its former size. It gives much more detail on construction of pipelines for handling sodium; heating of sodium-carrying lines and valves; insulation, repair and alteration of lines; recommended gaskets, valves and vessels for handling sodium; pumping, transferring, filtering and purifying of the liquid metal; and instrumentation of liquid sodium systems.

In this section, a table has been added giving typical data on induction heating of sodium pipelines. The table on power requirements for electrical resistance heating has

MORE



The cover remains the same, but the contents have been updated and greatly expanded in U.S.I.'s new edition of the brochure, "Handling Metallic Sodium on a Plant Scale."



Illustration from U.S.I.'s new sodium-handling brochure shows magnetic flowmeter in sodium line at Mallory-Sharon Metals' zirconium and titanium plant, Ashtabula, Ohio.

Dec.

★

U.S.I. CHEMICAL NEWS

★

1959

CONTINUED

Sodium Book

been completely revised. Also up-dated and enlarged is the table of recommended hardware for piping systems.

Sources and Safety Stressed

The new edition emphasizes safety measures throughout the book, as well as in a special section devoted to the subject. Throughout the book, also, can be found plentiful mention of sources for equipment, offers of technical assistance on specific problems covered in the text, and many cross-references.

The number of figures illustrating the book—and this includes diagrams and photographs—has been increased by 50%. The additions consist largely of interesting new installation photos. To aid the reader, most diagrams have been enlarged and made more legible.

Copies of the third edition of "Handling Metallic Sodium on a Plant Scale" may be obtained from U.S.I. upon request.

Three New Appointments in U.S.I. Sales Divisions



BROOKS

Albert C. Brooks has been named Manager of the U.S.I. Baltimore Sales Division, succeeding James F. Whitescarver who retired this September. Mr. Brooks has been with U.S.I. for over a quarter century, in plant work, sales, and most recently as Assistant Sales Division Manager in Baltimore.



PARKER

Roy A. Parker has been appointed Kansas City-St. Louis Division Manager for U.S.I. Mr. Parker has been associated with the company for about 33 years and, prior to his new assignment, was Manager of the Kansas City, Mo. Sales Office.



LONGSTRETH

Joseph G. Longstreth has been named Manager of U.S.I.'s St. Louis Sales Office. He has been a sales representative for the company in the St. Louis area since he joined U.S.I. in 1955.

Louis area since he joined U.S.I. in 1955.

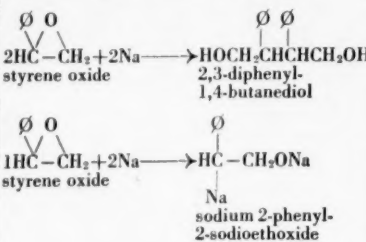
Reactions of Sodium and Compounds Discussed at Organometallic Symposium

At the Organometallic Chemistry Symposium, conducted as part of the 15th Southwest Regional Meeting of the ACS at Baton Rouge, La., on December 3, U.S.I. researchers contributed two papers on organosodium compounds.

In a paper entitled "Reactions of Disodiooctadienes," by Nobis, Robinson, Allgeier and Moormeier, it was indicated that the reaction of these compounds with oxygen or an oxygen-containing material such as an epoxide, aldehyde, ketone or chloromethyl ether, leads to a great variety of long-chain glycols. They are produced in high yield and contain eight to fourteen carbon atoms, depending on the reactant. Straight and branched chain compounds are present and easily separated.

Also covered in the paper was the ability of disodiooctadienes to metalate a variety of olefins and aromatics to yield other organosodium compounds such as allylsodium, butenylsodium, phenylsodium and benzylsodium, along with the mixed octadienes as by-products.

A paper entitled "Reactions of Sodium with Epoxides," by Mador and Robinson, revealed that such reactions result in a cleavage of the oxirane ring. The products are either 1,4-glycols (by dimerization) or a novel type of organosodium alkoxide, depending on the ratio of sodium present. For example:



These reactions are carried out with sodium dispersions in "active" ether solvent media at low temperatures. Other examples and some discussion of mechanism were presented.

Copies of either or both of these papers may be obtained from U.S.I. upon written request on company letterhead.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

New disposable polyethylene boots for technicians in biological and atomic laboratories, where spreading of contamination is a problem, are now on market. Made of lightweight film, boots give several hours of wear over shoes. **No. 1540**

Treatment of industrial foaming problems with silicones is described in new bulletin. Discusses causes of foaming, control methods, selection of proper defoamer, equipment, techniques for evaluating defoamer effectiveness. **No. 1541**

Expanded zirconium sheet can now be obtained in sheet thicknesses from .020" to .125" into 1/8", 1/4", 1/2" diameters, in standard sheet sizes, as unflattened or flattened mesh. Gives resistance against strong or hot phosphoric, hydrochloric, sulfuric acid solutions. **No. 1542**

New fire extinguishing system for small, hard-to-protect areas has been developed. Uses high pressure liquid CO₂ in easily stored cylinders. System can be installed in limited space in warehouses, industrial plants, laboratories. **No. 1543**

Rocket propellants are covered in detail in a new 224-page book now being sold. Contents include composition, production, performance for solid and liquid systems; burning, ignition, igniters; rockets using each type fuel; safety. **No. 1544**

New marking and decorating ink for treated or untreated polyethylene is now available. Said to remain permanently flexible and does not chip when flexed. **No. 1545**

New attachment for two-pan analytical balances designed to convert them into recording instruments that automatically plot weight changes of few tenths of milligram up to 5 grams. Accessory has own electrical damping control. **No. 1546**

Industrial solvents and monohydric alcohols discussed in new book now being sold. Presents physical properties, azeotropic mixtures, manufacturing methods, uses of industrial alcohols. Includes many significant tables and figures. **No. 1547**

Induction heater just introduced operates at 120 mc., believed to be highest frequency ever obtained on commercial machine. Rapidly heats highly resistive conductors. Acts as dielectric heater of nonconductors like polyethylene. **No. 1548**

Chemical marketing problems in the 1960s are forecast in a new book which can now be purchased. The volume consists of a collection of papers presented at the national meeting of the ACS in September, 1959. **No. 1549**

PRODUCTS OF U.S.I.

HEAVY CHEMICALS

Sodium, Metallic: cast solid in tank cars, steel drums, pails; bricks in barrels, pails.
Phosphoric Acid, Fertilizer Grade
Ammonia, Anhydrous: commercial & refrigeration. Tank cars or tank wagons.
Ammonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions
Sulfuric Acid: all strengths, 60 Baume to 40% Oleum. Also Electrolytic grade to Federal specifications. Tank cars or tank wagons.
Caustic Soda, Chlorine
Sodium Peroxide

OTHER PRODUCTS

PETROTHENE® Polyethylene Resins

Pharmaceutical Products: DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Intermediates.

Alcohols: Ethyl (pure and all denatured formulas); Anhydrous and Regular Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL® M, ANSOL® PR.

Organic Solvents and Intermediates: Normal Butyl Alcohol, Amyl Alcohol, Fuel Oil, Ethyl Acetate, Normal Butyl Acetate, Diethyl Carbonate, DIATOL®, Diethyl Oxalate, Ethyl Ether, Acetone, Acetoacetanilide, Acetoacet-Ortho-Chloranilide, Acetoacet-Ortho-Toluidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate, Urethan U.S.P. (Ethyl Carbanate), Riboflavin U.S.P.

Animal Feed Products: DL-Methionine, MOREA® Premix (to authorized mixer-distributors).

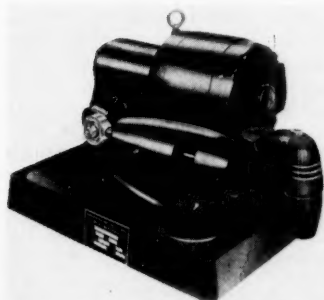
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 99 Park Avenue, New York 16, N. Y.

nal tube; the sample-handling lines are then purged with solvent and blown dry with compressed air or other gas.—**Applied Physics Corp., Monrovia, Calif. 212A**

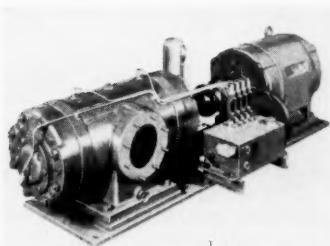


Chemical Feed Pumps

Move corrosive fluids into high-pressure systems.

Repetitive metering accuracy of the new 200 Series controlled-capacity pumps is $\pm 1\%$. Exhibited for the first time at the Chem Show, the pumps have a rated capacity of 812 gph. with simplex design. Duplex pumps have double this capacity. Maximum pressure is 10,000 psi.

Each pump comes equipped with a self-contained lubricating system that makes lubrication shutdowns unnecessary. Liquid ends made of various alloys are easily interchangeable in the field at minimum cost.—**American Meter Pump Div., Philadelphia, Pa. 215A**



Booster Compressor

Sliding-vane machine added to company's line.

Designed for low-temperature application, the Vilter Rotary Booster will fit readily into



NUGENT DUPLEX FILTER

keeps all the lube oil clean
for this Gas Turbine

The 7000 HP General Electric gas turbine shown above is destined for service in an East Texas chemical plant. A Nugent 1555BF-4L4 Duplex Filter is an integral part of the turbine system. Each filter comprising the duplex has a capacity of 150 GPM of 125 SSU viscosity lubricating oil. All the oil in circulation is filtered every cycle before going to the bearings. Foreign solids as small as 5 to 10 microns are removed; thus, harmful impurities cannot reach vital parts to accelerate wear.

Nugent Filters can lengthen the service life of your valuable equipment . . . reduce downtime . . . cut maintenance costs. Let us show you how. Write for information today.



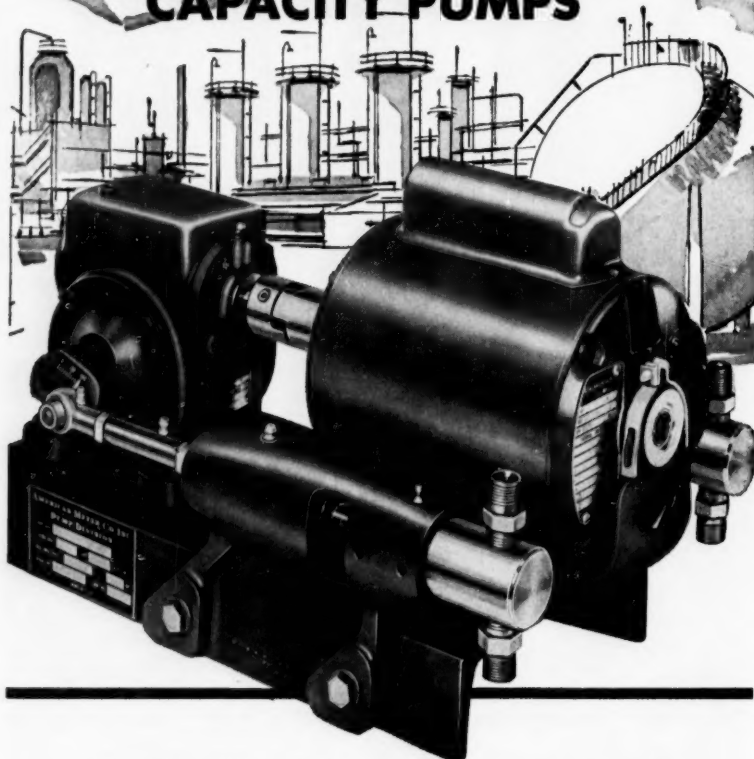
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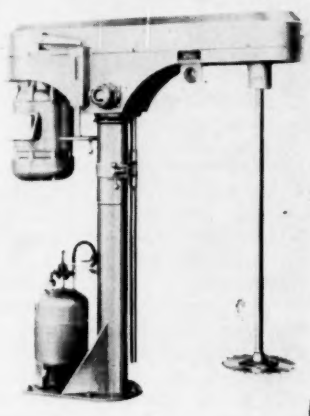
High Pressure Pumps • Controlled Capacity Pumps • Chemical Feed Systems

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NEW EQUIPMENT . . .

multistage systems as the first or booster stage. Ranging in capacity from 4 through 400 tons of refrigeration, the compressor can use ammonia, Refrigerant-12 and Refrigerant-22. Of sliding-vane design, VRS has a mechanically-driven, force-feed lubricator.

Says company, absence of all reciprocating parts eliminates vibration and shock, resulting in smooth and steady operation. Efficiency is claimed to be quite high.—The Vilter Mfg. Co., Milwaukee, Wis. 215B



Dissolver

Maximum power delivered over full speed range.

Newest, variable-speed dissolver of the manufacturer's line features a new power-transmission system capable of delivering over 90% of motor horsepower to the impeller, even at lowest speed. Designated MPD, the machine has capabilities for mixing, dispersing and deagglomerating operations.

Utilization of variable-pitch-diameter pulleys and belts enables maintenance of maximum available horsepower at the selected speeds. Speeds may be changed during or between batches without appreciable loss of horsepower output, regardless of changing physical characteristics of product.—Morehouse-Cowles, Inc., Los Angeles, Calif. 216A

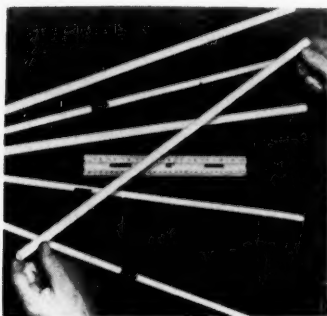


Electronic Thermometer

Reads virtually any processing temperature.

Weighing only 12 lb., the new Wide-Range Electronic Thermometer measures temperatures throughout 12 ranges covering the span of -425 to 800 F. Features include easy pushbutton range selection, direct readings in deg. F., and an accuracy of $\frac{1}{2}$ deg. F. over the major portion of the measuring span.

Power supply can be either a self-contained "C" battery or a 60-cycle, 110-v. source. All components operate well below their peak ratings and will give long, trouble-free operation, according to the manufacturer.—**Trans-Sonics, Inc., Burlington, Mass.** 217A



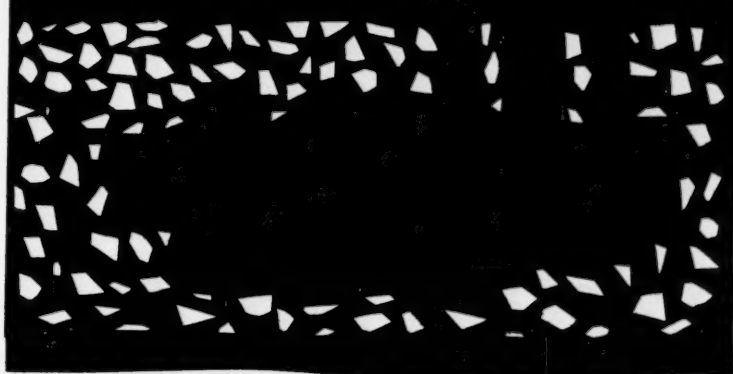
Ceramic Tubing

Resists elevated temperatures and thermal shock.

Beryllium oxide ceramic tubing in lengths to 24 in. is available for insulation and protection of thermocouples and other sensing and measuring elements used at extremely high temperatures or where heavy radiation

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Typical Chemical Analyses:

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SiO ₂	0.02%	0.02%	0.10%	0.10%
Fe ₂ O ₃	0.02	0.02	0.02	0.02
TiO ₂	0.002	0.002	0.002	0.002
Na ₂ O	0.60	0.50	0.10	0.04
Loss on ignition	0.70	0.10	0.15	0.15
Al ₂ O ₃ (by difference)	98.658	99.36	99.5	99.6

This wide range of top grade aluminas is designed to meet your specific performance requirements. For prompt service, or for complete specifications on any special alumina product, call or write Kaiser Chemicals Division, Dept. A9633; Kaiser Aluminum & Chemical Sales, Inc., at any of the regional offices listed at right:

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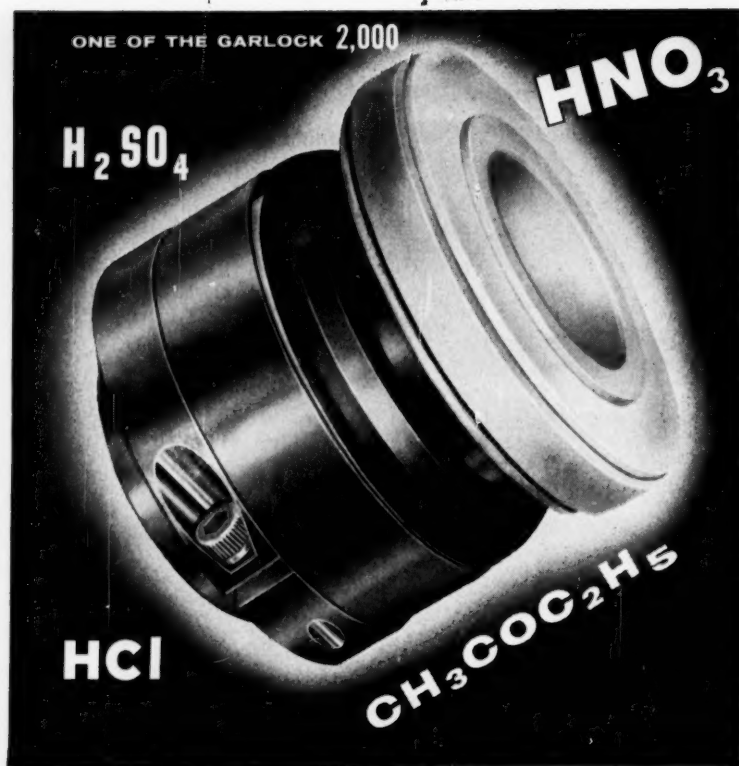


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- **Pumping HYDROXYACETIC AND SULFURIC ACID**
1750 rpm, 1½" shaft, 10 lbs. suction, 60 lbs. discharge. Temperature of medium 30° C. RESULT: Chemiseal greatly extended service life.
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3600 rpm, 625 lbs. discharge, 30 lbs. suction. Stuffing box pressures 15 lbs. to 65 lbs. Temperature of medium 70° C. RESULT: Chemiseal gave longer, leak-proof operation.
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1750 rpm, 1½" shaft, 2 lbs. suction, 45 lbs. discharge. Temperature of medium 65° C. RESULT: Chemiseal gave longer life.
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NEW EQUIPMENT . . .

is encountered. Called Berlox, the tubing may also find application in sampling devices for withdrawing materials from areas where corrosive conditions are extreme.

Properties of Berlox include a melting point of 4,650 F., high hardness and abrasion resistance, high electrical resistivity combined with high thermal conductivity and immunity to heavy doses of radiation. The high-fired surface is permanently dust-free, thus eliminating toxicity problems. Inside diameters vary from 5 mm. to ⅝ in.—National Beryllia Corp., North Bergen, N. J. 217B

BRIEFS

Fans for solvent recovery application feature gas-tight and spark-resistant design to minimize the possibility of explosions. The 50-in.-dia. radial wheel is fabricated of aluminum, and has a cast manganese-bronze spider. Variable inlet-vane control provides automatic volume regulation. Capacity at 1,780 rpm. is 19,000 cfs.; static pressure specification is 42.5 in. water.—American-Standard, Industrial Div., Detroit, Mich. 218A

Weighing system for application with bins, tanks, tank trucks and conveyor loads has a repeatable accuracy of better than 0.1%. Changes in floor construction or foundations prior to installation are unnecessary. Actual installation time is ordinarily less than 1 hr. Capacity range varies from 0-300 to 0-200,000 lb.—Weber Air-Weight Co., Detroit, Mich. 218B

Laboratory recorder features maximum accuracy at a minimum cost. Suggested applications include gas chromatogram installations, incorporation in titration assemblies, etc. Chart width is 250 mm.—E. H. Sargent & Co., Chicago, Ill. 218C

Plug valve for pressures ranging from full vacuum to 150

psi. incorporates O-rings to effect a dead-tight seal. Made of brass, the valve is available in female sizes from $\frac{1}{4}$ to $\frac{3}{4}$ in.—Circle Seal Products Co., Pasadena, Calif. 218D

Continuous centrifugal with 6-in. solid bowl operates at speeds to 6,000 rpm. Manufacturer recommends the machine for separations involving moderate volumes, limited space or extra-powerful separating force. Bowl and conveyor are cantilever-supported for quick and easy servicing. — Bird Machine, South Walpole, Mass. 219A

Temperature controller for multichannel operation is dust- and moisture-proof, and is not damaged by shock or vibration. Utilizing sensing elements of resistance wire, the instruments compare measured values with set-point reference voltages. Up to five separate proportioning or on-off points mount on a single power-supply chassis. —Electronic Processes Corp., San Francisco, Cali. 219B

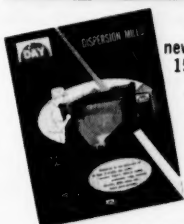
Equipment Cost Indexes . . .

	June 1959	Sept. 1959
Industry		
Avg. of all	234.3	235.8
Process Industries		
Cement mfg.	227.9	229.9
Chemical	235.7	237.5
Clay products	221.5	223.4
Glass mfg.	222.5	224.2
Paint mfg.	226.6	228.0
Paper mfg.	227.1	228.8
Petroleum ind.	231.4	232.9
Rubber ind.	234.0	235.7
Process ind. avg.	232.8	234.1
Related Industries		
Elec. power equip.	246.7	239.4
Mining, milling	237.1	239.0
Refrigerating	264.7	266.4
Steam power	221.8	223.2

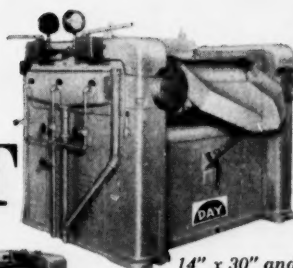
Compiled quarterly by Marshall and Stevens, Inc., of Chicago, Ill., for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; Feb. 23, 1959, pp. 149-50 for annual averages since 1913.

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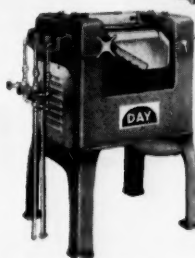
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for full
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10" x 22"
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production and
pilot operation
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Day 3-Roll Mills give you fast, consistent production at the exact fineness of grind you desire . . . are easiest to set-up, control, and to clean . . . give you years of trouble-free service at lowest maintenance costs. There's a Day Mill size to meet your batch requirements exactly — and all mills except the 5" x 12" are convertible for either fixed or float-a-roll operation.

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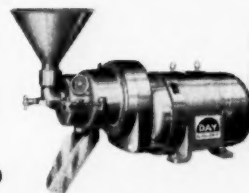
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Division of The Cleveland Automatic Machine Co.
4926 Beech Street, Cincinnati 12, Ohio

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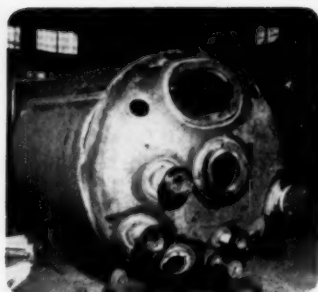


DAY PONY MIXERS

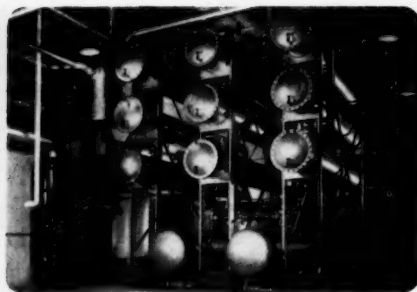
assure speedy, thorough pre-mixing of vehicles and pigments. A model for every need or application — single motion and twin motion mixing action—working capacities from 3 to 125 gallons.



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Condensers, Receivers, Oil Separators, Gas and Liquid Coolers, Accumulators, and Pre-coolers are furnished in all sizes.

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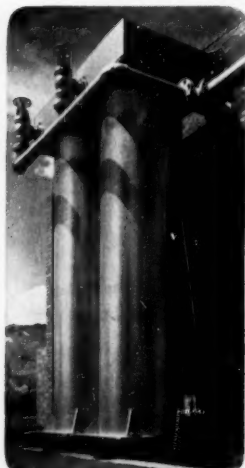
Look to



Engineers

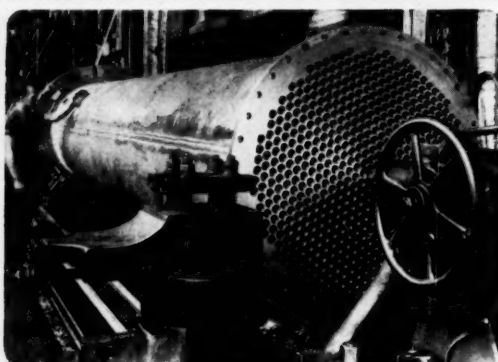
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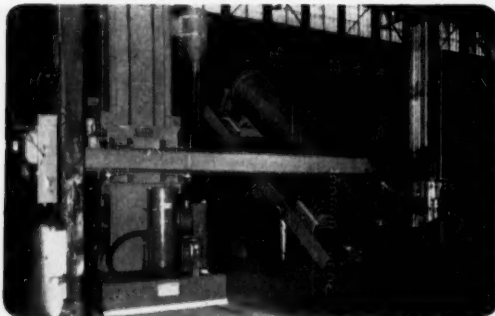


Frick vertical shell condensers.

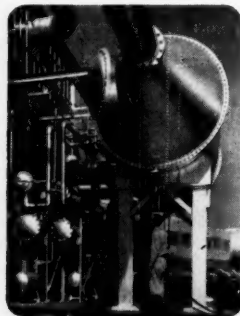
WAYNESBORO, PENNA., U.S.A.
FRICK Co.



Machining the head for a shell and tube vessel in the Frick shop.



Automatic welder used on a shell and tube vessel in the Frick shops at Waynesboro, Penna.



Compressed air for a wind tunnel conditioned with Frick equipment.

TECHNICAL

Reflects the Changes

CHEMICAL ENGINEERING ECONOMICS. By Chaplin Tyler & C. H. Winter, Jr. McGraw-Hill Book Co., Inc., New York, 4th Ed., 1959. 192 pages. \$7.

When Chaplin Tyler, then a *CE* editor, produced the first edition of his book in 1926, he saw an imbalance in the technical as against economic training a chemical engineer got. He put his thumb in the economic pan then, and in each decade since he has pushed down just a little harder with succeeding editions.

The fourth edition, written with a DuPont colleague, reflects the changes in engineering economic thinking over the generation since the first edition—indeed, in only the decade since the third.

► **Published Costs**—It's instructive, for example, to examine the extent to which equipment costs are now available as compared with earlier years. In 1926, the equipment for only three unit operations was used in a chapter on costs, nor was much added in 1938. But by 1948, considerably more correlated data was in the literature; the problem was a lack of comparable data from one source to another.

In 1959, it's no longer a problem of data (though constant updating will always be required. Now it's the problem of choosing the estimating method. Chemical publications now regularly produce cost data in recognition of a continuing duty.

But Tyler and Winter are not concerned with the details of cost data or cost estimating. Rather they show the various economic functions in a modern chemical company. Although they relate these functions, it seems to me to the detriment of their effort that treatment of actual engineering economics is sacrificed for treatment of corporate economic functions.

Be that as it may, both student and practicing engineer will gain knowledge of the working

BOOKSHELF

J. B. BACON

areas of economics in their industry. For the student, it opens vistas of everyday economic interaction that make Adam Smith and David Ricardo come alive; for the professional, the authors show how one corporate economic segment fits into another.

► **The Job They've Done**—After defining the CPI and management organization of companies within it, the authors discuss two economic areas of importance to the manager—cost accounting and financial analysis. They then take up management of research and outline the functions of market research.

Three chapters—process development, project engineering and manufacture—describe steps in commercial chemical development. Discussion of marketing and management studies concludes the book.

Although a generation ago Tyler set out to improve engineering economic thinking, what has evolved is a most readable account—albeit more from the manager's view than the engineer's—of chemical company economics. Perhaps a change of title is due.

The book is well indexed, but it needs a better bibliography. —WCS

BRIEFLY NOTED

CHLORINE MANUAL, 3rd ed. *Chlorine Institute, Inc.*, 342 Madison Ave., New York 17, N. Y. Broader in scope than previous editions, manual is a compendium of experience with materialism equipment and practices that contribute to safe handling, storage, shipment and uses of chlorine. The manual includes extensive bibliography.

LUBRICATING OILS AND GREASES IN THE SOVIET UNION, PB 151294. 114 pp. *Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.* \$2.50. Comprehensive army study of recent Soviet literature describing Russian developments in field of lubricants and lubrication.



ACIDS, CORROSIVES AND SOLVENTS



HOT LIQUIDS



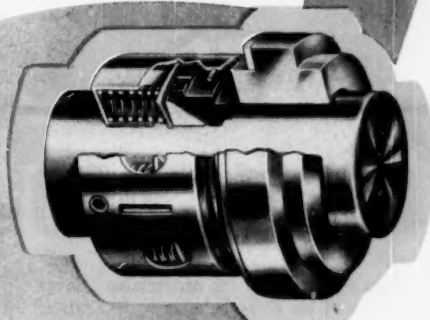
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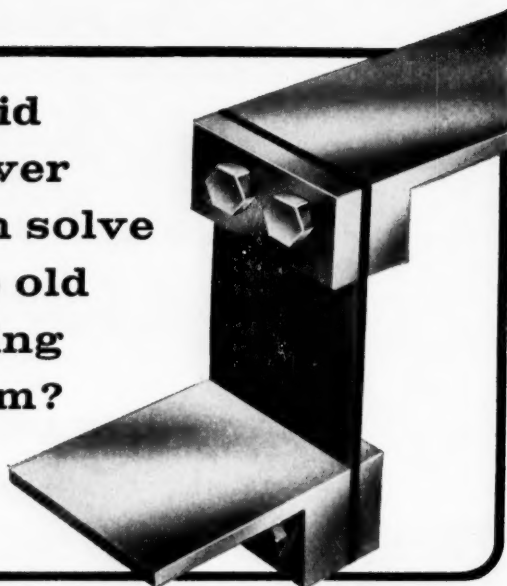
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this lever
system solve
an age old
weighing
problem?**



Early man was aware of the progressive inaccuracies of his pivot balance scales . . . but none knew how to remedy the situation.

The problem was solved in 1956 when the United States issued a patent for a "Thayer Flexure Plate" Leverage System. A team of engineers and businessmen aware of industry's tremendous cumulative loss of materials in weighing operations, had devised a revolutionary new scale.

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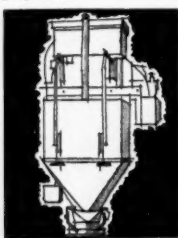
lever withstands shocks and vibrations indefinitely. Dirt and dust are no longer a problem. Thayer guarantees this leverage system accurate for the life of the scale.

How Can It Save You Money Year After Year?

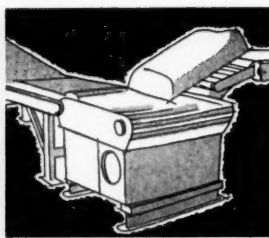
Working in conjunction with straight electrical controls, it forms the most reliable, low maintenance system ever devised to control processing or materials handling by weight. Literature on its application to filling, batching and checkweighing operations is available on request.



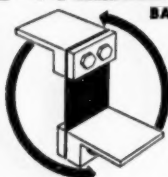
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CHECKWEIGHING



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LETTERS:



JUST BETWEEN US...



Dear Readers:

Many of you, especially of my generation, have fond memories and great respect for my editorial predecessor, Dr. Howard C. Parmelee. He died in Florida, November 17, within a few days of his 85th birthday. His long, productive career covered the whole span of chemical engineering as we know it today (see our 50th Anniversary issue, July 1952).

Parmelee literally grew up in the process metallurgy of the West, with such contemporaries as Dorr and Oliver, Whitaker and Moore. He worked alongside Acheson, Baekeland, Castner, Dow, Hooker and others who first wedded electrochemistry and engineering at Niagara. Later he was elected president of the American Electrochemical Society.

In 1922 he succeeded Arthur D. Little as chairman of the AIChE committee on chemical engineering education, and a year later, as secretary of the Institute, he put its authority behind the academic accredita-

PRO & CON

C. H. CHILTON

tion program, subsequently adopted by the entire engineering profession. As chairman of a distinguished committee of educators and industrialists he helped to launch McGraw-Hill's chemical engineering series of text and reference books—thus providing the first coordinated book literature of our profession.

But to those of us privileged to work closely with him, "Parm" was a never failing source of inspiration. His friendliness, courage and intellectual integrity, his even-tempered judgment, his constant encouragement of his fellow men—these were the human qualities that endeared him to us all. We shall miss him, for many of our lives have been enriched by his example.

SIDNEY D. KIRKPATRICK
Editorial Director
Chemical Engineering

Worth All That Space?

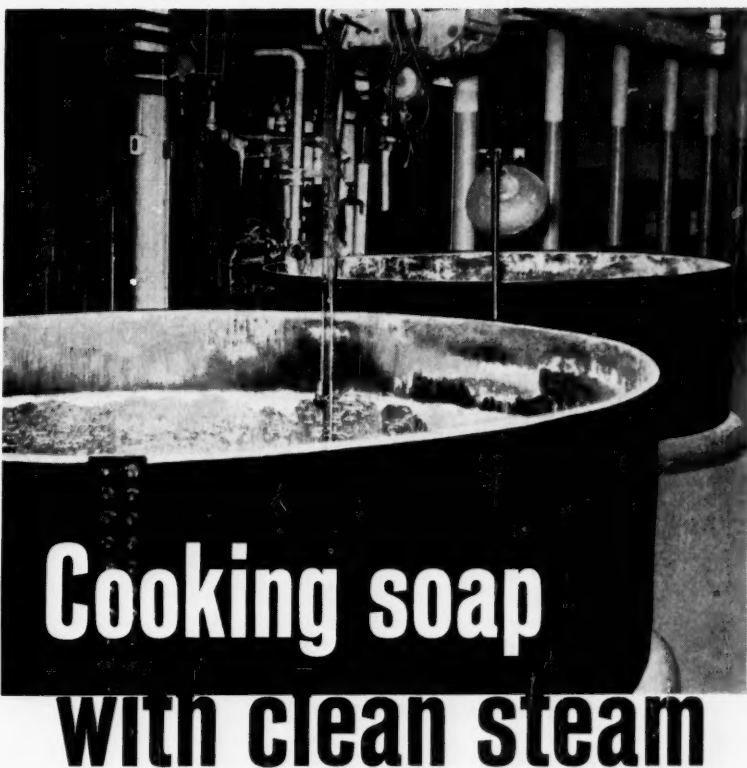
Sir:

Having waded through Dr. Kern's 16-page article on "Speculative Process Design" in your Oct. 5 issue (pp. 127-142), I wonder why you thought it was worth all that space. Frankly, I think very little of the article.

I do agree with the idea of designing a large commercial plant early in the development of a new process, not only to check probable economics, but also for the discovery of problems, unknowns, missing data, etc., which can be uncovered only by such an approach.

How much better it is to find what you need, or will need, early in the game rather than late! Such early design, even though based on assumptions which, at that time, may be quite unfounded, although necessary, will result in a better experimental approach and a better study of the variables concerned.

This I have always believed and practiced so far as possible. And this point is, I think



Potter Drug & Chemical Corp. (Malden, Mass.) cuts steam costs for soap processing and plant heating with Cleaver-Brooks high- and low-pressure packaged boilers.

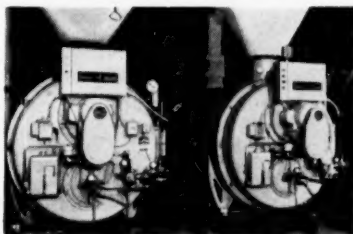
The makers of famous Cuticura soap have a dual need for clean, economical steam. For processing, the company requires adequate quantities of steam for agitating, heating and drying soap solutions. For heating four buildings, they depend on a reliable source of low-pressure steam.

In modernizing, like so many chemical plants, Potter Drug specified Cleaver-Brooks boilers. Results were remarkable! The high-pressure 200-hp CB boiler provides ready supplies of dry steam for processing soap. The low-pressure, 200-hp Cleaver-Brooks boiler easily heats the four story building and three smaller buildings, including the manufacturing and office areas.

Management claims, "We are money ahead in eliminating operational delays, in fuel savings, and

quick response for our production and heating requirements with these Cleaver-Brooks four-pass boilers. Our operating efficiency is now 80%. This is much better than we were getting from the two-pass boilers. We also like the operating convenience and ease of servicing the new Cleaver-Brooks boilers."

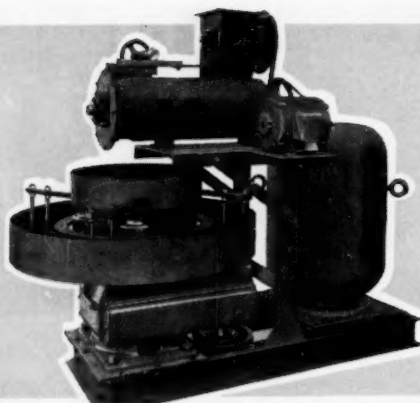
For complete information on Cleaver-Brooks packaged boilers (15 to 600 hp), contact your representative or write Cleaver-Brooks Company, Dept. P, 345 E. Keefe Ave., Milwaukee 12, Wisconsin.



FAST STEAM — Mr. Robert Johansen, plant engineer, reports that Cleaver-Brooks four-pass design boilers produce steam much faster than old two-pass types.

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ORIGINATOR AND LARGEST PRODUCER
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NEW SOLUTION To Your PELLETING PROBLEMS



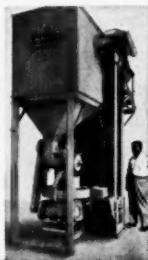
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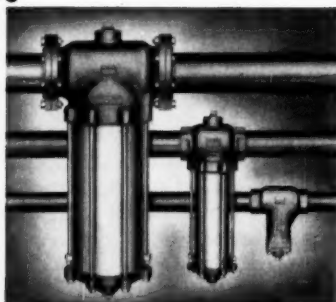
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... gives complete
information

PRO & CON . . .

(though it is a bit hard to be sure), made in Kern's article.

WALTER E. LOBO

Consulting Chemical Engineer
New York, N. Y.

Con: Personnel Engineer

Sir:

I was interested in Mr. Obrochta's article on the "Personnel Engineer" in your Oct. 19 issue (pp. 210-216).

There can be no doubt that Mr. Obrochta's services are very useful to Convar and that other organizations could beneficially use the services of similar individuals.

I was, however, very disturbed to learn that the title "Engineer" is being further corrupted to cover those whose only relationship to the profession of engineering is the contact they make with engineers in the performance of their assignments. By no stretch of the imagination can Mr. Obrochta's functions or responsibilities be classified as engineering in accordance with any of the definitions given by ATChE, EJC or NSPE.

I am surprised that a reputable organization like General Dynamics Corp. would permit the title "Engineer" to be used so indiscriminately. Mr. Obrochta is qualified neither by education nor experience to use this title.

If engineers are to acquire the professional status they so earnestly seek, use of the term "engineer" should be zealously restricted to those persons so qualified by education and experience.

R. F. BURGHARDT

New Canaan, Conn.

Sir:

Your recent article about "personnel engineering" has left me flabbergasted and somewhat irritated at the thought of yet another group of people bestowing upon themselves the title of "Engineer."

The duties of a "personnel engineer" as outlined in the article seem no different from those performed by any competent personnel man, except that he happens to deal mostly with technical people. Why must he

strive for a more imposing title?

WILLIAM L. GROSS
New York, N. Y.

Sir:

I wish to take exception to your use of the title "Personnel Engineer."

All the functions described in your article are those normally associated with any good personnel department qualified to hire and handle technical people. None of the functions requires the type of specialized training which an engineer receives in one of our accredited engineering colleges.

Indiscriminatory use of the title "Engineer" does not help the profession gain the recognition for which it has been striving.

DANIEL KAUFMAN
Harshaw Chemical Co.
Hastings-on-Hudson, N. Y.

► One of the above letters accuses the personnel man of being a status seeker. The other two letters strongly imply that engineers also are status seekers. It must be a national disease.—Ed.

Process Energy Sources

Sir:

In my article on "Energy for Process Industries" (July 13, pp. 131-142) there occurred an unfortunate error which affected the entire worked-out example on p. 141.

Herewith is a corrected version of this example. In order to eliminate the need for changing any of the significant figures elsewhere in the article, I have arbitrarily assumed that natural gas is worth 80¢/1,000 cu. ft. instead of 70¢.

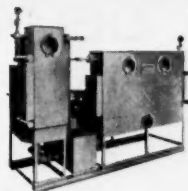
HERBERT ARGINTAR
James P. O'Donnell Engineers
New York, N. Y.

► Corrections were made on reprints of the article. If you clipped and filed the original you might wish to clip and file the corrected portion below, representing six paragraphs on p. 141.—Ed.

Next, we estimate the LPG standby consumption. Approximately 11 gal. of liquid propane equals 1,000 cu. ft. of natural gas. Hence, LPG equals $15.4 \times$

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bagging petrochemicals.

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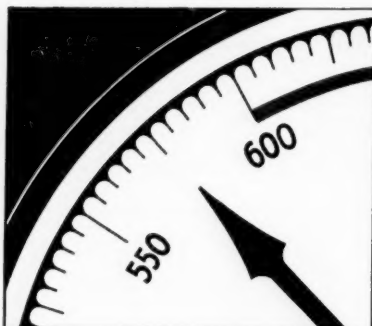
59-3C

name & title
company
street
city zone state

AROCLOR SYSTEMS DELIVER STEADY PROCESS HEAT TO 600°F and ...

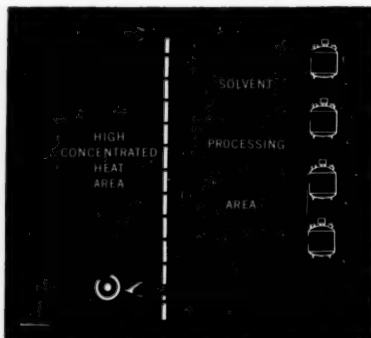
PINPOINT HEAT CONTROL...

to within 2° F. Indirect heating with Aroclor 1248 ends processing problems from local hot spots and overheating. Units range from small, portable electric types to large, gas- and oil-fired heaters generating up to 20,000,000 BTU's per hour. Typical uses: cooking of alkyd resins, dyestuff synthesis and other chemical reactions, deep-fat frying and other food processing, drying ovens and molding equipment.



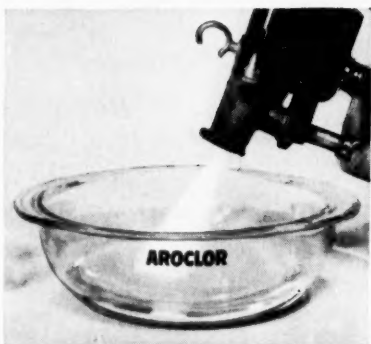
ECONOMY!

Unpressurized systems cost less to install and maintain than pressurized systems. Forced circulation of liquid Aroclor requires no condensers, vaporizers, traps, heavy-walled jackets or complex feed mechanisms. Compact design saves space. Heat from a single unit can be supplied for multiple uses at different temperatures. Total efficiency saves processing dollars.



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Dept. IF-4, St. Louis 66, Mo.

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PRO & CON ...

$10^3 \times 11/10^3 = 169.4$ gal./day. Allowing for thermal efficiency, standby requirement of LPG for annual outages is $169.4 \times 4 \times 6$ or 4,060 gal./yr.

Storage costs for small tanks in this area are approximately \$2/gal. If we use a tank having a gross capacity of 5,000 gal., we can obtain adequate storage for a full year's standby operation. The total cost for this tank is $\$2 \times 5,000$ or \$10,000.

Unloading equipment, vaporizer, diluting valve and tank water cooling will cost about 80% of storage cost. Hence, the other equipment will add $\$10,000 \times 0.80$ or \$8,000. Total installed cost of the standby equipment is \$18,000.

Propane at 11¢/gal. is equivalent to \$1.21/1,000 cu. ft. of natural gas. Incremental cost of using standby LPG is $(\$1.21 - 0.80)$ or \$0.41/1,000 cu. ft. of gas. Total cost of using standby LPG during natural gas curtailment is $15.4 \times 10^3 \times \$0.41/10^3 = \$63/\text{day}$.

Weather conditions at this location may cause six 4-day shutdowns per year. Cost of outage because of loss of profit, wages, etc. is \$810/day. Hence, six outages of four days each cost $24 \times \$810$ or \$19,440. Thus, the LPG installation is worth approximately \$19,500 per year.

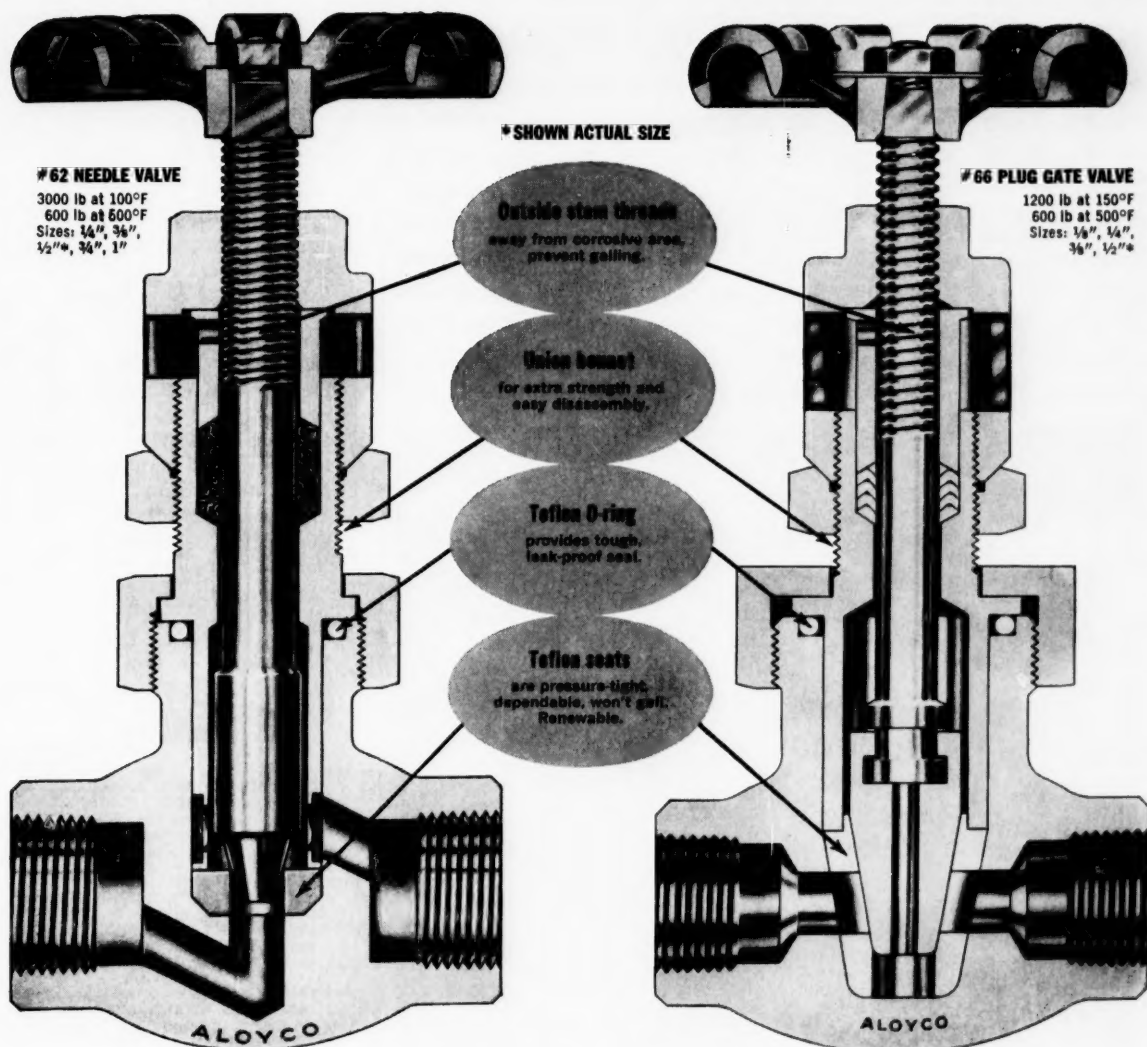
Incremental cost of LPG fuel for a total of 24 days outage is \$1,500 over natural gas. By using the standby LPG, there is available \$18,000 for amortization of standby facilities. Since these facilities cost \$18,000, amortization will occur in approximately one year.

Serves as Trip Report

Sir:

Your article on new cryogenic rocket fuels (Nov. 2, p. 69-74) is an excellent discussion of the Propellant Thermodynamics and Handling Conference which I attended in July. I combined your article with my trip report and the pictures I took from the slides, and had quite a complete report of my own.

DAVID ROLLER
Magna Products Inc.
Santa Fe Springs, Calif.



radically different ALOYCO Stainless Steel Valves eliminate leakage and galling common to ordinary fine control valves

Introduced eight years ago, these two small Aloyco valves have proved themselves in many types of severe corrosive service as well as handling hard-to-hold fluids and high-pressure gases.

The No. 62 Needle Valve (left) is particularly suitable for sensitive control of flow . . . as in metering or sampling for process plant, laboratory or pilot plant use.

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2-4



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TECHNICAL

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Services & miscellaneous	253

Chemicals

Acid Inhibitors. are ideal for all types of specialized industrial cleaning requirements. Data File & Selection Chart describing Rodine Inhibitors are offered.
236 Amchem Products, Inc.

Acrylate Monomers. The properties, polymerization, inhibition, storage, handling & shipment are covered in a bulletin "Celanese Acrylate Esters," which is offered.
93 *Celanese Corp., Chemical Div.

Activated Carbon. Booklet describes types and various applications of activated carbons in both liquid and vapor phase adsorption. Available on request.

119 *Pittsburgh Coke & Chemical Co.

Activated Carbons. A complete line for every purpose; design & pre-fabricate complete purification, separation & recovery system to meet your needs. Bul. J-100.
L209 *Barnebey-Cheney

Alkyd Resins. 6 p. bulletin 4 contains data for the alkyd formulator on the use of company's poly-ether acid N-1 in alkyd resin formulation. Includes test data.
228A S. C. Johnson & Son

Benzoyl Chloride. Data on this chemical is now available on request. The complete story on benzoyl groups is included with this data.
136c *Hooker Chemical Corp.

Benzyl Chloride. has a characteristic pungent odor. It's insoluble in water but dissolves readily in alcohol & ether. Specifications & typical data offered.
136b *Hooker Chemical Corp.

Calcined Aluminas. Two grades: KC-1 and KC-2 are high-purity, uniform quality aluminas, both available in coarse & fine particles. Technical brochure offered.
217 *Kaiser Chemicals Div.

* From advertisement, this issue

LITERATURE

E. M. FLYNN

Chemicals......The latest edition of the Reilly Chemical Index is just off the press. A copy of this valuable index is available on request. Send for your copy.
265 *Reilly Tar & Chemical Corp.

Chemicals......Industrial solvents & monohydric alcohols discussed in new book now being sold. Presents physical properties, azeotropic mixtures, etc. No. 1547.
213-41 *U. S. Industrial Chemicals Co.

Diphenolic Acid......3 p. bulletin 5 describes a new water solution coating system based on DPA. Covers preparation, product characteristics, on enamel film.
229A S. C. Johnson & Son

Diphenolic Acid......4 p. bulletin 3 describes the polyether acids of DPA, suggests areas for research. Lists polyether acids available, drawings show structures.
229B S. C. Johnson & Son

Epoxy Resin......20 p. bulletin K-2967, "Kopoxite 159 Resorcinol Diglycidyl Ether (RDGE)," introduces a new resorcinol-based resin which wide selection of curing conditions.
229C Koppers Co.

Ethanolamines......New booklet on Alkanolamines & derivatives is available. Application information is combined with physical properties specifications & shipping data.
207 *Union Carbide Chem. Co.

Filteraids......Complete information on Nerofil for filtration and other uses is offered. Six product grades are available for your varying needs.
230 *Great Lakes Carbon Corp.

Fluorochemicals......FC 75 has outstanding value in electronics, where it serves as a coolant & insulating fluid. It is nontoxic, non-flammable, etc. Information available.
252-253 *Minnesota Mining & Mfg. Co.

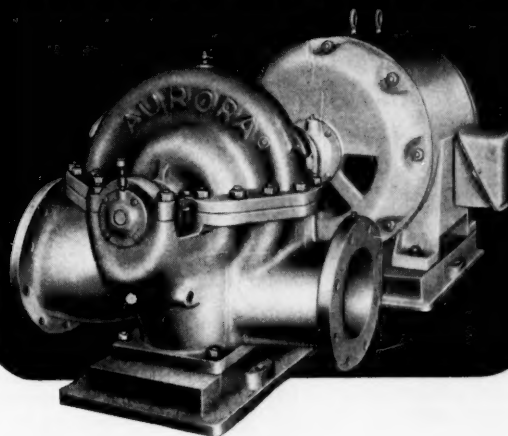
Fused Quartz......for ultraviolet transmission application, laboratory ware & production equipment. Also development for special requirements. Bulletin.
24-25d *Engelhard Industries, Inc.

* From advertisement, this issue

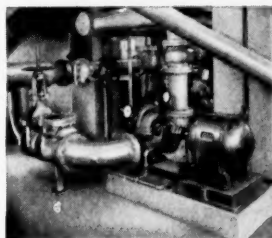
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Two Aurora Type "OJ" Condensation Water Pumps are installed in the Hillsborough County Courthouse, Tampa, Florida. Duty, 1400 GPM against 50' TDH at 1750 RPM.

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230A Central Soya Co.

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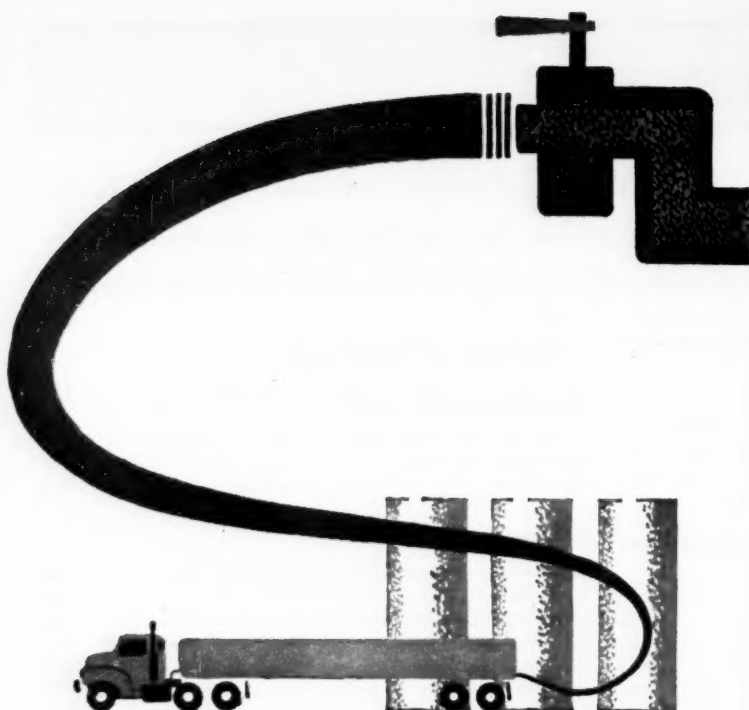
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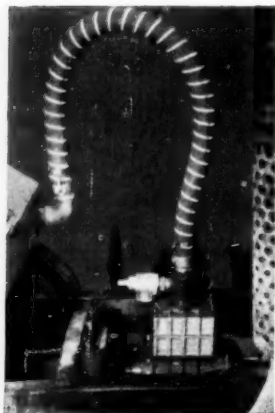
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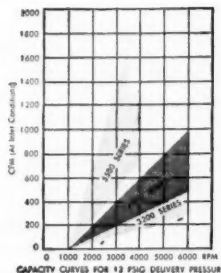
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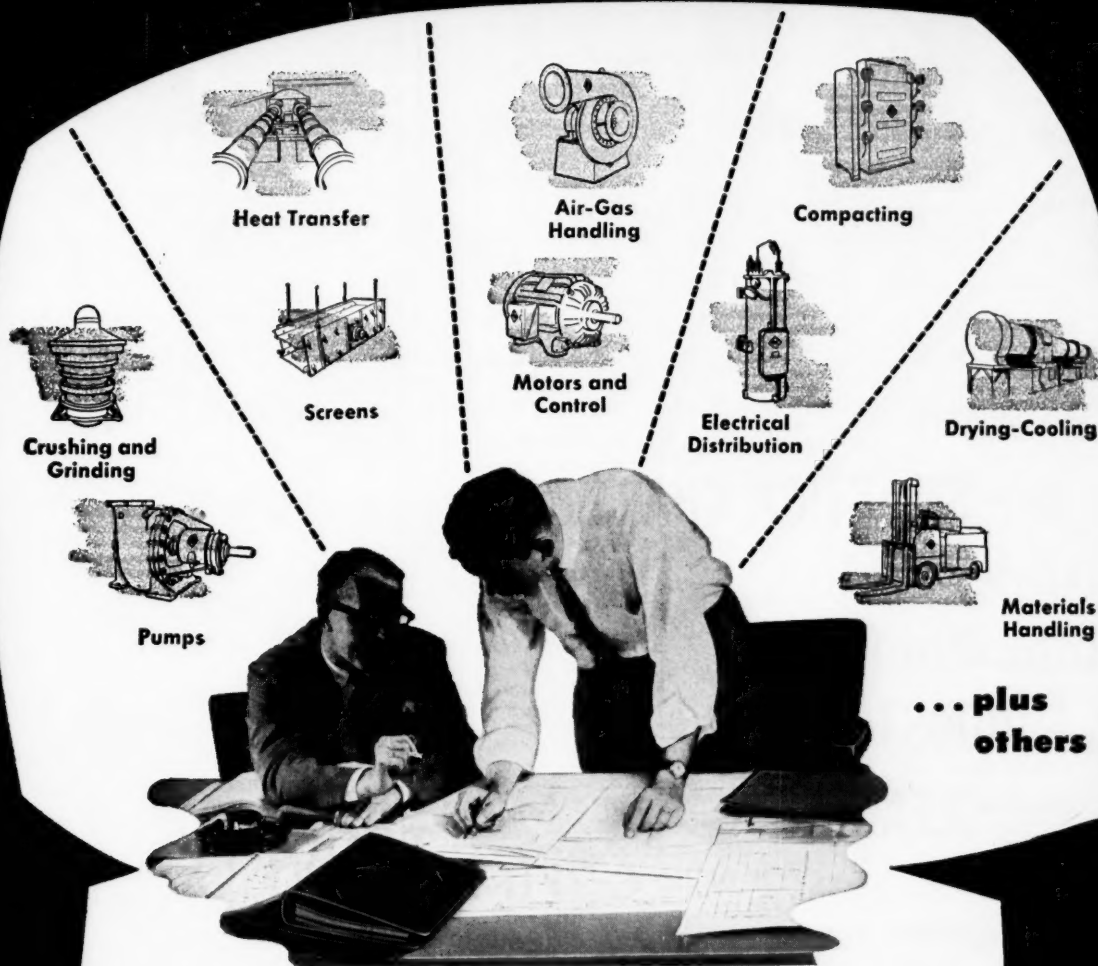
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Products for Petro-Chemicals: *Electrical Generation, Distribution and Utilization Equipment; Pumps (rotary vacuum and centrifugal); Compressors; Mechanical Power Transmission Equipment; Processing Machinery (mills, kilns, screens, etc.); Water Conditioning Systems, plus Materials Handling Equipment.*



A 5983 C

AMCHEM PRODUCTS, INC., AMBLER 49, PA.

Please send me "Data File" and Selection Chart describing uses of Rodine Inhibitors for Industrial cleaning.

NAME.....TITLE.....

COMPANY.....

ADDRESS.....

CITY.....ZONE.....STATE.....

CLIP THIS COUPON . . .

for **SELECTION CHART** on
Rodine Acid
Inhibitors
for **INDUSTRIAL**
CLEANING!



Now—available for the first time—a handy selection guide to let you easily determine the proper class of inhibitors to use for various metals and cleaning media!

Rodine Acid Inhibitors are ideal for all types of specialized industrial cleaning requirements. Rodine effectively inhibits acid solvents used to dissolve deposits in industrial equipment, tanks, and piping systems. Find out how Rodine can protect your investment in costly equipment by eliminating acid erosion.

Get all the facts . . . **TODAY!**



RODINE

another chemical development of Amchem Products, Inc.
(Formerly American Chemical Paint Co.)

AMBLER 49, PA. • Detroit, Mich. • St. Joseph, Mo. • Niles, Calif. • Windsor, Ont.

Amchem and Rodine are registered trademarks of Amchem Products, Inc.

LITERATURE . . .

Fabrication. The illustrated Weldment Bulletin 7001 gives you an excellent idea of the vast fabricating facilities that are available. Send for your copy.
126 *Baldwin-Lima-Hamilton

Metals. Illustrated brochure describes solid & clad base metals, solid & clad precious metals, thermostat metals, electrical contacts, & industrial metals.
236A Metals & Controls Div.

Pall Rings. in plastic offer advantages of low pressure drop & high capacity at less than one-fourth the weight. Four sizes: $\frac{5}{8}$ ", 1", 1 $\frac{1}{2}$ " & 2".
68 *U. S. Stoneware

Plastic Products. Complete line includes sheets, rods, tubes, tape, thin-wall tubing (available with permanent color striping) and bondable "Teflon."
202 *Raybestos-Manhattan, Inc.

Protective Coatings. for steel tank linings, concrete tank lining, tank cars, concrete floors, etc. Booklet describes protective coatings & other Plastic products.
L251 *Wisconsin Protective Coating Co.

Rubber & Plastic Tank Linings. for alkalis, acids, bleaches, salts. Faultless seams, indestructible bond, shock and age-resistant. Bul. CE-53.
210b *American Hard Rubber Co.

Stainless Steel. Wide selection of plates, sheets, bars and angles, rings and discs, heads, pipe and tubing are part of the large stock available for shipment.
150 *Joseph T. Ryerson & Son, Inc.

Titanium. the light, strong, corrosion-resisting metal which is the answer to difficult corrosion problems. Information on titanium in new profitable applications.
87 *Union Carbide Metals Co.

Vitreous Silica. Vitreosil for thermal shock resistance, for guarding purity of your compounds, for outstanding electrical properties, etc. Bulletins.
R251 *Thermal American Fused Quartz

Wire Cloth. from any metal or alloy including titanium. In nine basic weaves, from finest to coarsest mesh. Fill your most diversified bulk wire cloth needs.
141 *The Cambridge Wire Cloth Co.

Wire Cloth. for filtering, sizing, straining, testing. Hundreds of meshes, weaves and metals to fit your specific need. Information in Bulletin FC.
206 *Newark Wire Cloth Co.

Electrical & Mechanical

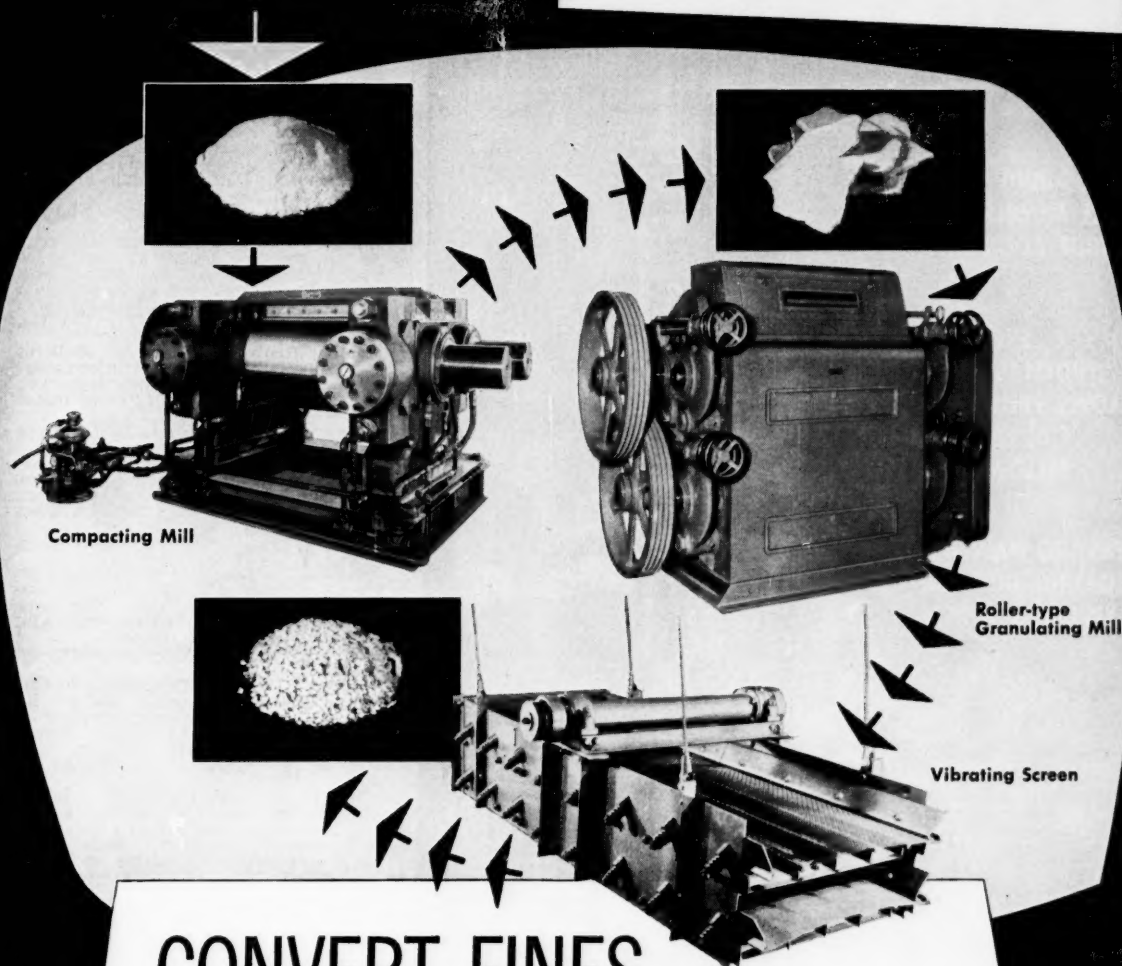
Couplings. Para-flex flexible cushion couplings are available from factory stock in capacities up to 2000 hp at 10 rpm. Requires no lubrication, no periodic inspection.
200 *Dodge Manufacturing Corp.

Drive. Adjusto-Spede drive is the answer to precise operating speeds for machine tools, process machinery, test equipment, windups, etc. Bulletins 2750 & 2800.
118 *The Louis Allis Co.

* From advertisement, this issue

SCOPE in INDUSTRY
SPECIALIZATION from

ALLIS-CHALMERS



CONVERT FINES

to high-quality granules with
a complete processing circuit

The Allis-Chalmers compacting process can turn 80 to 90% of your present waste fines into salable granules . . . often of higher quality than the granules produced in your original process. For example: Tests on products reconstituted by the Allis-Chalmers system have shown compacted granules to have better controlled solubility, more uniform particle size, better "eye-appeal" and freer flow.

Here's how fines are recovered: Waste or fine salts from the original process are fed into a compacting mill. The mill mechanically densifies the fines into flakes. Flakes are then granulated by a roller mill—separated and sized by a vibrating screen.

For more information, get Bulletin 07B8836 from your A-C representative or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

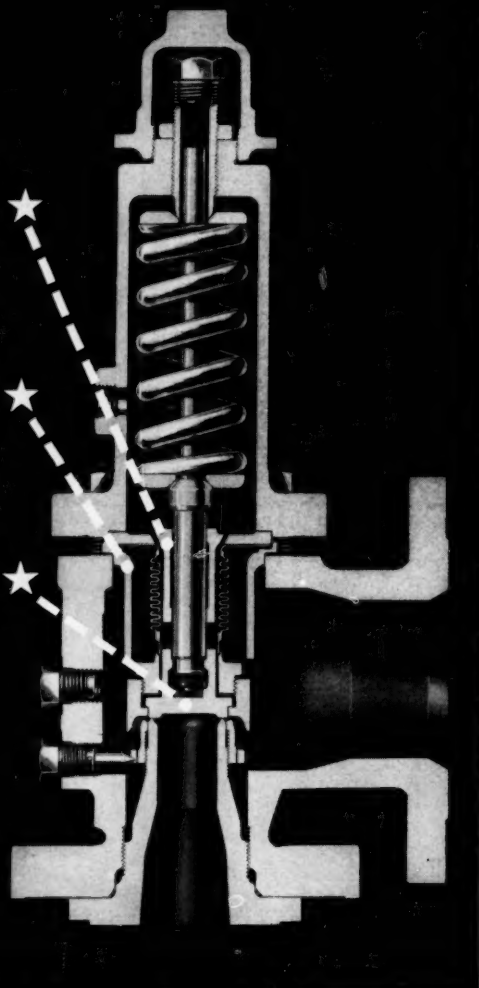


A-1191-C

GUIDING FROM
SINGLE MEMBER FOR
TRUE ALIGNMENT

EXCLUSIVE
"PROTECTO-SEAL"
BELLOWS PROTECTOR
FOR LONGEST
BELLOWS LIFE

EASY-TO-MAINTAIN
FLOATING DISC FOR
MAXIMUM TIGHTNESS



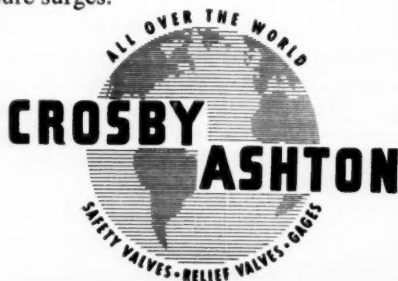
WHERE THERE'S NO COMPROMISE WITH SAFETY...

you need the absolute reliability of
Crosby Bellows-Relief Valves

Maximum protection against corrosion or fouling of working
parts and variable back pressure surges.

CROSBY VALVE & GAGE COMPANY
THE ASHTON VALVE COMPANY

Factory: Wrentham, Mass.
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CROSBY VALVE & ENGINEERING CO., LTD.
Wembley, England
S.A. J. COCARD, Lille, Nord, France



LITERATURE . . .

Gearmotors. . . . in a wide variety of sizes in single, double, triple or quadruple reductions, horizontal or vertical foot or flange mountings. Bul. MU-227.
130 *Wagner Electric Corp.

Mechanical Seals. . . . Chemiseal in standard sizes to fit all pump shafts from 3/4" to 2 1/4"; special sizes also available. Complete details in Catalog AD-164.
218 *The Garlock Packing Co.

Mills, 3-Roll. . . . give you fast consistent production at the exact fineness of grind you desire. Sizes to meet your batch requirements exactly. Bul. 158.
219a *The J. H. Day Co.

Motor Control Centers. . . . Bulletin SM-244 gives detailed information on all the "plus" advantages you get when you specify these motor control centers.
121 *Square D Company

Motoreducers. . . . available in horizontal, vertical & right angle types. Units are available up to 75 hp; output speeds from 780 rpm down to 1.2 rpm. Bul. 3100.
179 *The Falk Corp.

Motors. . . . Complete information on Synchronous Motors and their application is available. Also issue of Synchronizer titled "The ABC of Synchronous Motors."
123 *Electric Machinery Mfg. Co.

Motors. . . . SEALEDPOWER totally-enclosed fan-cooled motors include explosion-proof designs in all ratings up to 300 hp. Newest data given in Bulletin PB 6000.2 44-45
*Elliott Co.

Motors. . . . Life-Line "A" motors feature fool-proof sealing against corrosion, long life and low maintenance. Complete facts about these motors. Available on request.
38-39 *Westinghouse Electric Corp.

Planetary Gears. . . . may be used for all kinds of drives such as gas turbines, steam turbines, diesel engines, etc. Bulletin 2400 contains complete information.
12-13 *De Laval Steam Turbine Co.

Rectifiers. . . . Semi-conductor rectifiers such as germanium, silicon & selenium, as well as mercury arc rectifier units of the pumped or sealed type. Complete information.
239 *Allis-Chalmers

Rectifiers, Silicon. . . . offer low first cost, ease of installation, no costly outages, etc. Full information on silicon rectifiers for electrochemical applications.
20-21 *Westinghouse Electric Corp.

Speed Variators. . . . Power transmitted from input to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the 2 shafts. Bul. 55
*Cleveland Worm & Gear Co.

Thermocouples. . . . for just about every possible application. Large or small thermocouples for low or extremely high temperatures. Details in Bulletin EDS 47-E.
204 *Thermo Electric Co., Inc.

Turbines, Solid-Wheel. . . . for mechanical drives. Capacities from 5 to 2,000 hp., speeds up to 10,000 rpm. Vertical turbines built in sizes from 5 to 300 hp. Bul. S116.
66 *The Terry Steam Turbine Co.

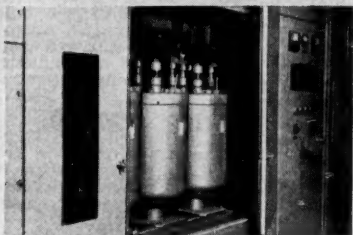
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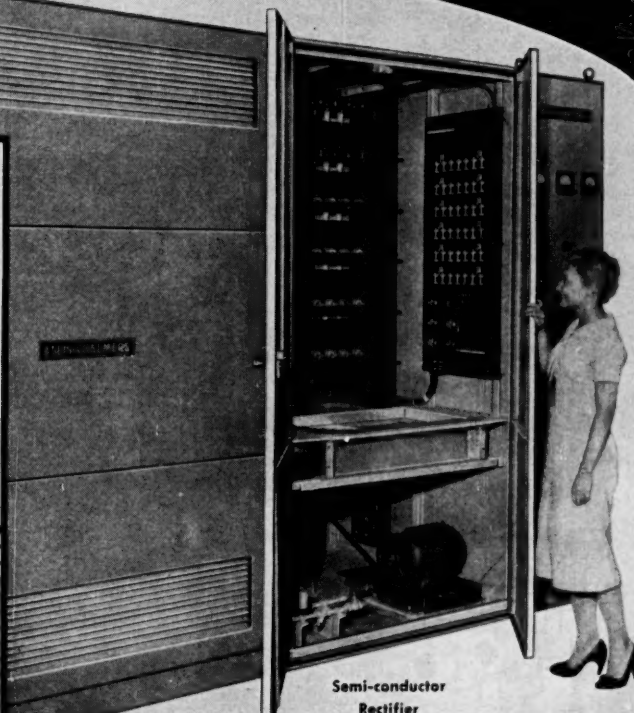
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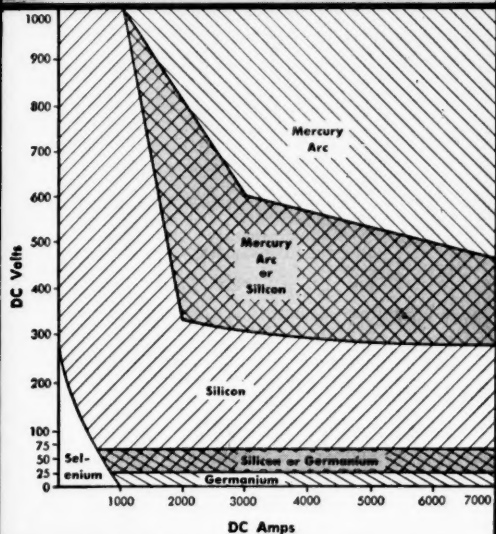
Open pumped tube Mercury Arc Rectifier



Enclosed sealed tube Mercury Arc Rectifier



Semi-conductor Rectifier



**Allis-Chalmers takes the
confusion out of
power conversion**
Right-for-the-job rectifier

**Available to
Electrochemical
Industries**

There's only *one* type rectifier that's *right* for your electrochemical application. Use the above chart as a guide. It shows the approximate direct current and voltage ratings that best fit the various types of rectifiers. After checking the chart, check with Allis-Chalmers. Thirty years' experience in developing, building and applying rectifiers equips A-C to analyze your needs and make a pinpoint recommendation.

Allis-Chalmers makes all static types

Allis-Chalmers builds semi-conductor rectifiers such as germanium, silicon, and selenium, as well as mercury arc rectifier units of the pumped or sealed type in open or enclosed construction. Because Allis-Chalmers can supply this wide variety of power rectifiers, our recommendation is always completely unbiased — never influenced by commercial expediency. For complete information, call your A-C man or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. In Canada, write Allis-Chalmers Ltd., Box 37, Montreal, Quebec.



A 5935 C



FORGED for long life PACKAGED for convenience

The "Forged" in W-S Forged Fittings means dependability under the toughest piping-job conditions. "Forged" gives you the added resistance to pressure, heat, corrosion, shock and vibration needed to make your installations long-lived and safe. And W-S Fittings are easily installed, with tight fits and perfect alignment... thanks to W-S precision machining methods and quality forging techniques.

Packaging, too, is a W-S brand advantage. Virtually any "mix" of fitting types and sizes can be packed in a convenient W-S Case or Half-case... each type and size in its own carton.

Specify W-S on your next order. For specifications and Distributor locations, write *Forge and Fittings Division, H. K. Porter Company, Inc., Box 95, Roselle, New Jersey.*

FORGE AND **PORTER** **FITTINGS DIVISION**
H.K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION; Specialty Alloys—RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRACTORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION, H. K. PORTER COMPANY DE MEXICO, S. A.; and in Canada, Refractories, "Disston" Tools, "Federal" Wires and Cables, "Nepcoduct" Systems—H. K. PORTER COMPANY (CANADA) LTD.

LITERATURE . . .

Handling & Packaging

Payloader..... Model H-25 offers combination of 2,500 lb. carry capacity, only 6 ft. turning radius, power-shift transmission, power-steering, etc. Data.
54 *The Frank G. Hough Co.

Weighing Instrument..... forms a low maintenance system to control processing or materials handling by weight. Literature on its application to filling, batching, etc.
222 *Thayer Scale Corp.

Weighing Systems..... Automatic measurement and control of bulk materials through unitized weighing systems of pre-engineered components is subject of new bulletin.
240A Weighing & Control

Heating & Cooling

Boilers, Packaged..... Complete information on packaged boilers (15 to 600 HP) and how they fit into your expansion or replacement plans are available on request.
223 *Cleaver-Brooks

Dielectric Heaters..... Loadmaster control permits maximum loading. Continuous full capacity operation assured. Additional information on request.
241 *Allis-Chalmers

Heat Exchanger Equipment..... with working pressures as high as 10,000 psi. Bulletin 827 outlines the industrial heat exchangers that are available.
250 *The Vilter Mfg. Co.

Heat Exchangers, Liquid/Gas..... for any application, alloy or size. Operating pressure: 1500 p.s.i. Additional information available on request.
138 *The Marlo Coil Co.

Heating Systems..... Aroclor systems deliver steady process heat. Information booklet on Aroclor 1248 heating systems and guide to heater selection offered.
226 *Monsanto Chemical Co.

Plate Heat Exchanger..... unit requires only 12,600 lbs. per hour of 60 F. water & maintains a temperature differential of 10 F. Additional information on request.
28-29a *De Laval Separator Co.

Induction Heater..... just introduced operates at 120 mc, believed to be highest frequency ever obtained on commercial machine. Rapidly heats highly resistive conductors.
213-4m *U. S. Industrial Chemicals Co.

Steam Jet Ejectors..... available from 1 to 7 stages—a few inches of vacuum down to one micron of absolute pressure—evacuating small or large loads. Bul. No. 70A.
77 *Graham Mfg. Co., Inc.

Steam Traps..... A 48-pg. book tells how to correctly size, install & maintain steam traps for any pressure, temperature or any load. Also Catalog K for data.
135 *Armstrong Machine Works

* From advertisement, this issue

SCOPE in INDUSTRY
SPECIALIZATION from...

ALLIS-CHALMERS

Loadmaster control permits
maximum loading

**Typical
Applications**

- Twist-setting rayon cord
- Heating plastic preforms
- Setting glue joints
- Jelling rubber
- Heating inert powders
- Preheating molding powders
- Rayon drying

**Continuous full capacity
operation assured with
Allis-Chalmers dielectric heater**

Set the *Loadmaster* control at a predetermined maximum and minimum load. An automatic circuit stops the conveyor belt when the maximum load is reached. As the material in the oven dries, the belt will start again at the minimum.

Loadmaster control and the resulting full capacity operation is just one of the many features of the Allis-Chalmers dielectric heater. Eye-level, "grouped" controls facilitate a quick appraisal of operating conditions. Protective interlock assures complete safety. Oscillators and rectifiers are built to last 5000 hours or more. Heavy duty plate transformers provide large reserve capacity. Most important, Allis-Chalmers extensive engineering and research facilities assure proper application and installation.

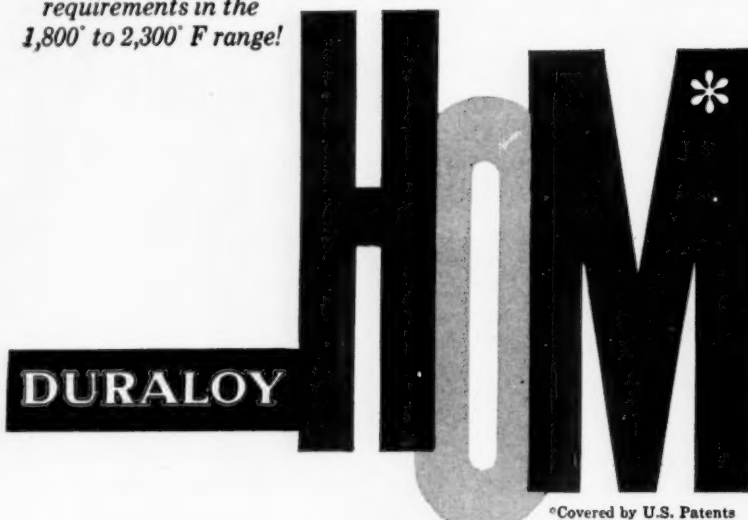
Call your nearby A-C man for details or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis. In Canada, write Canadian Allis-Chalmers Ltd., Box 37, Montreal, Quebec.

A-1001-C



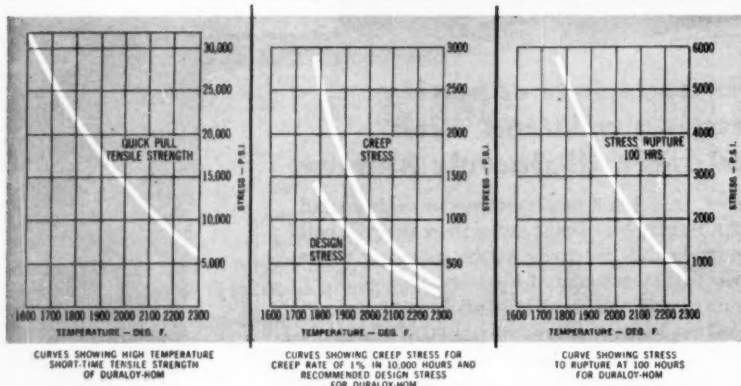
HOW TO BEAT THE HEAT

for strong high alloy
requirements in the
1,800° to 2,300° F range!



casting alloy

Duraloy "HOM" is a special high nickel alloy developed to produce castings that meet high temperature requirements, especially when castings are subject to oxidizing atmospheres.



Castings of DURALOY "HOM" are now being produced by our three methods: static, centrifugal and shell molded. Write today for additional information on this versatile new alloy.



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EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.

ATLANTA OFFICE: 76-41st Street, N. W.

CHICAGO OFFICE: 332 South Michigan Avenue

DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

LITERATURE . . .

Instruments & Controls

Annunciators. Illustrated catalog presents information on the operation and application of annunciator systems for various industries. Copy on request.
242A Scam Instrument Corp.

Control Element. A 29-page booklet describing the origin & operation of the snap-acting disc type thermal element called the Spencer Disc is now available.
242B Metals & Controls Div.

Controls. New recording pneumatic temperature control, model RVA is available in ranges from 30 to 1100 F. Recording, indicating & non-indicating models. Details.
60 *The Partlow Corp.

Data Processing Equipment. Publication describes L & N line of data processing equipment, including digital processing, and analog and digital computing systems.
242C Leeds & Northrup Co.

Electric Recorders. Bulletin GEA-6933 provides buying information on complete line of recording instruments. Dimensions, chart speeds, features and accessories.
242D General Electric

Electronic Computer. The Royal Precision LGP-30 operates in many process industry applications. No site preparation is necessary. Complete information on request.
191 *Royal McBee Corp.

Gauge. Complete details on the Liquidometer Gauge. Indicates the exact level at all times . . . shows it at a glance. Gauge operation is completely automatic.
212 *The Liquidometer Corp.

Indicator. Level-Tel 154 is a precise, continuous reading level indicating system consisting of a probe detector, transmitter, & indicator. Bul. RF-5915.
53 *Robertshaw-Fulton Controls

Indicator. The new 90K series pneumatic Dial Indicator features color coded target-type pointers against full 10" scale for easy reading. Details in Catalog 98347.
115 *Taylor Instrument Co.

Instrument. New attachment for two-pan analytical balances is covered in item No. 1546. Accessory has own electrical damping control.

213-4k *U. S. Industrial Chemicals Co.

Instrumentation. A complete line of instruments; full-size, miniature, electronic and pneumatic types for measurement, recording, automatic control and telemetering.
149 *The Bristol Company

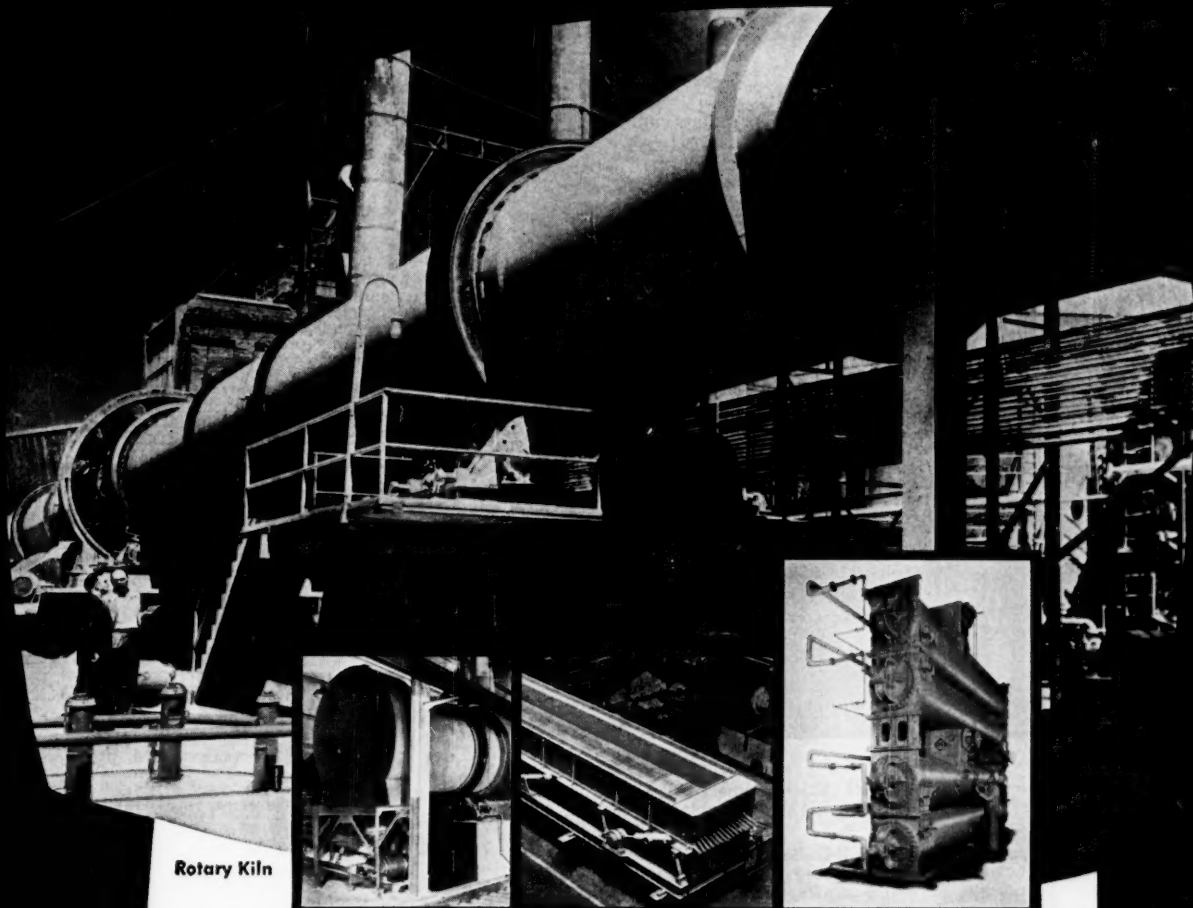
Magnetic Flow Meter. has no flow restrictions of any type . . . nothing to plug up. Full details on the high-accuracy, low maintenance of Meter contained in Bul. 20-14.
16-17 *The Foxboro Co.

Recorder-Controller. unit continuously & simultaneously records 4 variables on the same chart. Clear, easy-to-read records for continual analysis & control.
264 *Bailey Meter Co.

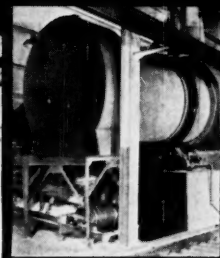
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SPECIALIZATION from...

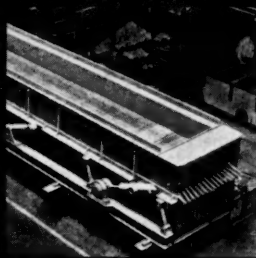
ALLIS-CHALMERS



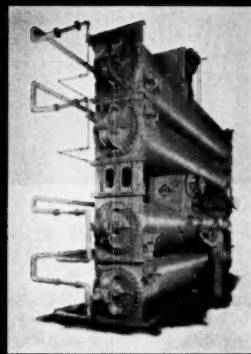
Rotary Kiln



Rotary Dryer



Air-Quenching Cooler



Ribbon-Flight Dryer

Integrated heat-transfer systems from Allis-Chalmers cut costs

At Allis-Chalmers, building a heat-transfer system is not just a matter of picking components and hooking them together.

A-C relates the flow variables of each component to the characteristics needed for the whole process.

Typical of the research and testing facilities which make this thorough analysis possible is the new A-C pilot plant which includes a complete *Grate-Kiln* system.

Components, processes and techniques may be studied carefully under actual operating conditions. The results from these tests help A-C bring you the latest scientific advances in pyro-processing in each system you buy.

For more information, talk with your A-C representative. Or write for Bulletin 25C6177, to Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis.



A-1190-C



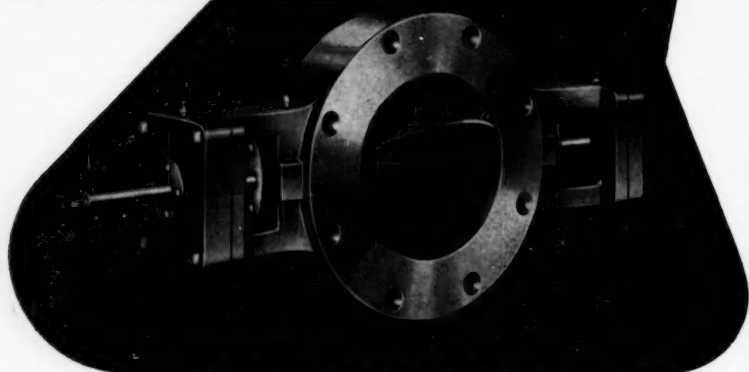
With Allis-Chalmers
Valves

BALL VALVES

BUTTERFLY VALVES

ROTOVALVES

WAFER VALVES.....



Here's a new wafer valve—with Allis-Chalmers full-bodied design—that incorporates many of the highly-desirable features of two-flanged butterfly valves.

Rugged Construction—A-C full-bodied design affords full protection; there is no chance of cracking around bolt holes. Vanes are pinned to stainless or monel shafts with high-tensile pins. Oversized outboard roller bearings and retaining plates are used. Rugged standard mounting brackets provide maximum support for any operator in any position.

Flexibility—Valves can be provided in a wide variety of alloys to handle all types of fluids and semi-solids over a wide temperature and pressure range. They may be equipped with almost any operator, which may be mounted in several positions on standard A-C bracket assemblies.

Through Rubber Seats—Full rubber seats on A-C Wafer Valves afford maximum body protection and positive, bubble-tight shutoff. Standard seats are of natural gum rubber, neoprene or hycar. Other materials are available on request.

Size Range—Full-bodied A-C Wafer Valves are available in standard sizes from 3 to 36 inches in both 125# and 150# A.S.A. series, rated as shutoff pressure of 50# and 125#.

For information on the complete line of Rotovalves, and butterfly, ball and wafer valves, contact your nearest A-C valve representative, or write Allis-Chalmers, Hydraulic Division, York, Penna.

RESEARCH DESIGN
Hydraulic Division **HYDRODYNAMICS** Rotovalves • Ball Valves • Butterfly Valves • Free-Discharge Valves
ENGINEERING FABRICATION Hydraulic Turbines & Accessories • Pumps • Liquid Heaters



ALLIS-CHALMERS

LITERATURE . . .

Scientific & Test Instruments.....

Catalog gives information on calibration instruments, data handling systems, magnetic tape instrumentation, oscillographs, etc.

244A

Minneapolis-Honeywell

Viscometran.....Viscosity can be continuously process controlled with the Viscometran. Complete information on how it can provide "in process" measurement.

R245 *Brookfield Engineering Lab., Inc.

Pipe, Fittings, Valves

Expansion Joints.....The Expansion Joint Design Guide features 28 pages of valuable information on expansion compensators, flexible connectors, etc.

91

*Flexonics Corp.

Expansion Joint.....Teflon expansion joint molded of Flouroflex-T outlasts most other materials & constructions. Offers high tensile strength. Bulletin B-1A.

89

*Resistoflex Corporation

Fittings.....Forged Steel Fittings give you the added resistance to pressure, heat, corrosion, shock, & vibration. Specifications & Distributor locations on request.

240

*H. K. Porter Co., Inc.

Pipe.....Tempron non-metallic pipe for hot chemicals to 275 F. Also handles tough organics. Rigid tough nitrile. Pipe & fittings to 8". Bul. 96A.

210a

*American Hard Rubber Co.

Pipe.....All purpose rigid PVC in schedules 40, 80, & 120, 1/2" to 4". Threaded or socket-weld fittings. Valves 1/2 to 2". Bulletin CE-56. Send for your copy.

211a

*American Hard Rubber Co.

Pipe, Plastic.....Flexible poly pipe is ideal for water lines, drains, underground pipe or conduit. In sizes 1/2 to 2", long coils. Details in Bul. CE-57.

211c

*American Hard Rubber Co.

Pipe.....Saran lined pipe, fittings, valves & pumps are available for systems operating from vacuum to 300 psi, from below zero to 200 F. Information available.

127

*Saran Lined Pipe Co.

Tubing.....Ace-Flex is non-toxic, odorless, tasteless, sterilizable, flexible tubing. Excellent for chemicals, foods, and for lab or machine lines. Bul. 66.

210c

*American Hard Rubber Co.

Valve.....New Pressure Sealing gate valve is designed for pressures up to 720 psi (cwp) and temperatures up to 250 F. Catalog 1200 is available.

81

*W-K-M Div. of ACF Industries

Valve, Needle.....The No. 62 is particularly suitable for sensitive control of flow . . . as in metering or sampling for process plant, laboratory, etc. Facts.

227a

*Alloy Steel Products Co.

Valve, Plug Gate.....The No. 66 is ideal for instrument lines, in small lines handling viscous liquids, or where a low pressure drop is important. Facts.

227b

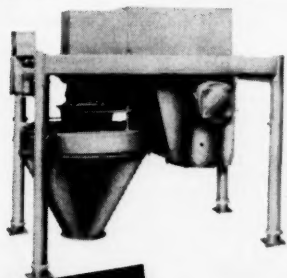
*Alloy Steel Products Co.

* From advertisement, this issue

THE IMPACT^{MILL}

The Modern Method of Grinding

The IMPACT MILL (utilizing centrifugal force and shattering impact to effect particle size reduction) out-performs traditional grinding mills on many jobs in many ways.



Free test runs
on your material.

ADVANTAGE: CLOSELY CONTROLLED PARTICLE SIZE

Its unusual ability to consistently deliver the desired particle size with a remarkably low percentage of fines or over-sizes is a distinct advantage in the processing of a wide range of materials, even down to sub-sieve ranges.

TYPICAL APPLICATIONS:

Talc reduction	Carbon black
Fine grain flour	Pigments
Polyethylene resins	Insecticide dusts

ENTOLETER

S Division of **SAFETY INDUSTRIES, INC.**
P. O. Box 904 • New Haven 4, Connecticut

CONTAMINATION-FREE COMPRESSION

For All Types of Gases—



CORBLIN

Diaphragm-Type
Compressors

- Absolutely no contact between gas and hydraulic fluid; gases are compressed between hydraulically-pulsed diaphragms.

- Compressors lend themselves to easy automatic operation when control is by pressure switch.

- Units can apply additional compression to gas taken directly from commercial bottles.

- Units operate efficiently with fluctuating input pressure, without need for pressure reducers or expansion vessels.

- Pressures available to 30,000 psi.—capacities to 60 s.c.f.m.

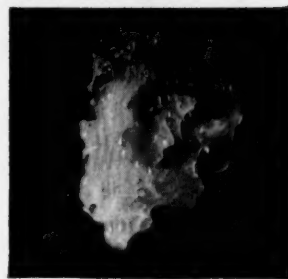


Write For Free Aminco Bulletin 4071—C

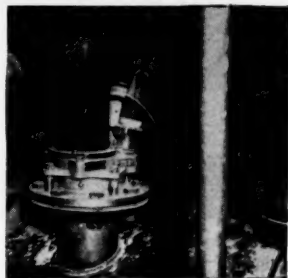
AMERICAN INSTRUMENT CO., INC.

8030 Georgia Ave., Silver Spring, Md.

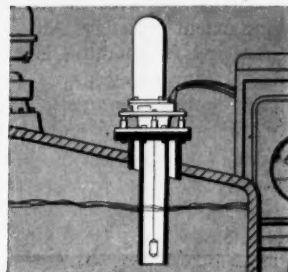
YES, NOW VISCOSITY



CAN BE CONTINUOUSLY PROCESS CONTROLLED



WITH THE BROOKFIELD VISCOMETRAN



UNDER actual process conditions, the Brookfield Viscometran accurately and continuously measures, records and controls viscosity. Readily mounted and integrated in existing processes, the Viscometran offers significant economic advantages over other methods of indicating degree of reaction, degree of polymerization or determination of process end point. Viscosity is very likely a variable that is fundamental in your process. For complete information about how the Brookfield Viscometran can provide continuous "in process" measurement of this product dimension for you, write—

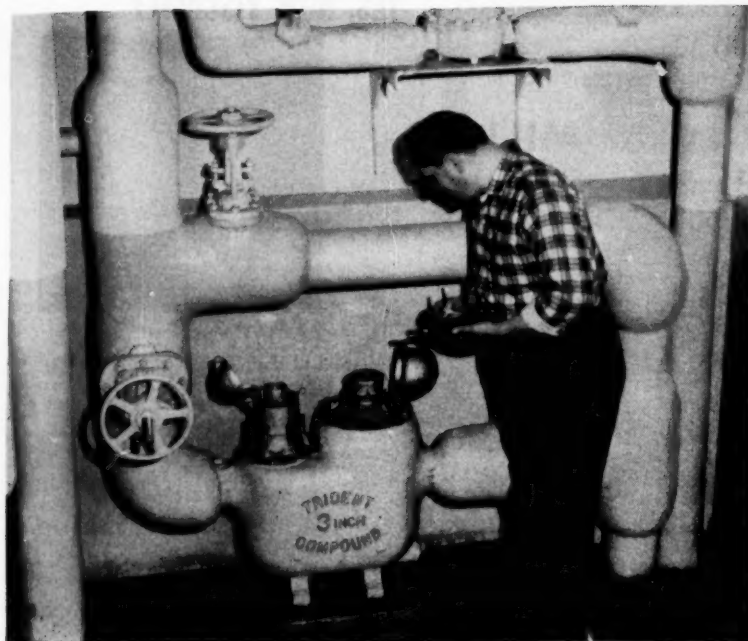
THE WORLD'S STANDARD FOR VISCOSITY
MEASUREMENT AND CONTROL



Brookfield

ENGINEERING LABORATORIES, INC.

STOUGHTON 33, MASSACHUSETTS



How Ansco's 101 NEPTUNES save millions of gallons daily

Snapshots at popular prices depend to an amazing extent on *water*. Ansco Manufacturing Company, Binghamton, N. Y., needs many million gallons every day...water for vital heating, cooling, air conditioning...expensively treated water for chemical processes.

Cutting water costs to the bone, Ansco has found ways to re-circulate and re-use water an average of $2\frac{1}{2}$ to 3 times before it is reluctantly released.

Key to the program is metering. Over 100 Neptune water meters keep guard 24 hours a day. Each department is charged for the water it uses. The meters help compute heating and cooling values, blending proportions, chemical treatment required, etc., for most economical re-use.

If water is important to *you*, make sure you too are saving all you can with meters. We'll gladly make a survey. No obligation, of course.



GET THE FACTS

Ask for helpful
Meter Data
Bulletin 566 M
See Neptune Data
Pages in Chemical
Engineering Catalog.

NEPTUNE METER COMPANY

19 West 50th Street • New York 20, N.Y.

Life History of a Gallon of Water at Ansco

1. Well water at 53° used first for air conditioning
2. Chlorinated, used for spray washing
3. Used in chemical dehumidifier
4. Passes through heat exchanger
5. Passes through ammonia condenser
6. Goes to fire protection reservoir
7. Finally used to cool roof

neptune

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SAN FRANCISCO (Millbrae)

— IN CANADA: TORONTO 14, ONT.

LITERATURE . . .

Valve, Wafer......available in standard sizes from 3" to 36" in both 125# & 150# A.S.A. series, rated as shutoff pressure of 50# & 125#. Information on complete line.
244 *Allis Chalmers, Hydraulic Div.

Valves......Aluminum alloy valves are available in sizes from $\frac{1}{2}$ " through 24". Aluminum gate valves specifically for severe corrosive conditions.
56 *Darling Valve & Mfg. Co.

Valves......Plastic-coated or uncoated Eccentric Valves can provide the positive answer to your valving problems. Complete information on request.
37 *De Zurik Corporation

Valves......Line Blind Valves offer positive action, easy operation, long-life service & lasting safety. One man can open or blind a line in less than one minute. Catalog.
262 *Hamer Valves

Valves......Guide bulletin indexes the manufacturer's valve line with those of 16 major manufacturers. Contains valve trim chart, list of frequently used abbreviations.
246A Ohio Injector Co.

Valves, Control......for hot or cold flows . . . or other process flow conditions. Available in a wide range of types & sizes. New Catalog C800-1.
64 *Minneapolis-Honeywell

Valves, Diaphragm......available in body, lining & diaphragm materials to meet your particular service conditions. All the facts are available on request.
134 *Grinnell Company

Valves, Drain......cannot clog up. Designed so that in the closed position the piston or ram extends up into the tank. In open position, full flow assured. Catalog.
R209 *Strahman Valves, Inc.

Valves, Plug......A complete line of lubricated plug valves with sizes from $\frac{3}{4}$ " to 36" and pressures to 15,000 lb. Details available on request.
128-129 *Rockwell Mfg. Co.

Valves, Solenoid......are covered in an 8-page article entitled, "How To Specify Solenoid Valves." It includes diagrams and charts on the different series.
246B Valcor Engineering Corp.

Valves, Stainless......Brochure gives you the complete technical data on Crane 18-8 SMO and other stainless steel valves. Bulletin AD-2411. Send for your copy.
147 *Crane Company

Valves, Stainless Steel......A new catalog outlines patterns you want, in a choice of alloys that satisfy the requirements of practically all corrosive services.
85 *Jenkins Bros.

Process Equipment

Air Separators......Nine models available with diameters from 3' to 18'. Feature precise separation and improve screening. Information in Bulletin No. O87.
R263 *Sturtevant Mill Co.

*From advertisement, this issue

For Immediate Service
PHONE MAIN 6-3712

**BLINDS • SPACER
RINGS • TEMPORARY
and LINE STRAINERS
• PIVOT FLANGES**



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1901



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132 WARREN STREET
WRITE TODAY FOR CATALOG A-9

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Vacuum Dryers • Blenders and
Mixers • Ball Mills • Autoclaves •
Paint and Paste Mixers •
Agitators



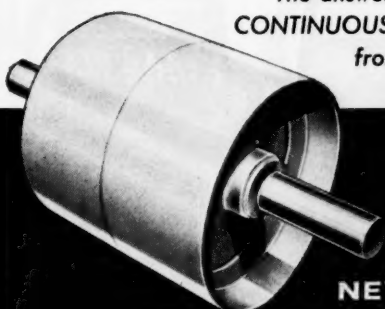
Impregnators • Vacuum Pumps •
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tings • Code Design • Fabrication



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CONTINUOUS SEPARATION of TRAMP IRON
from fast-moving deep burdens



DINGS

**NEW CERAMIC TYPE
PERMANENT MAGNETIC PULLEY**

CERAMOX VI! That's Dings' new, powerful ceramic magnet material which protects processing machinery from costly tramp iron damage and removes contaminating iron particles from a wide variety of dry, granular chemicals and other materials to assure product purity. Dings' new ceramic radial-pole Perma Pulleys provide high magnetic strength across the entire belt width and greatest removal efficiency from deep

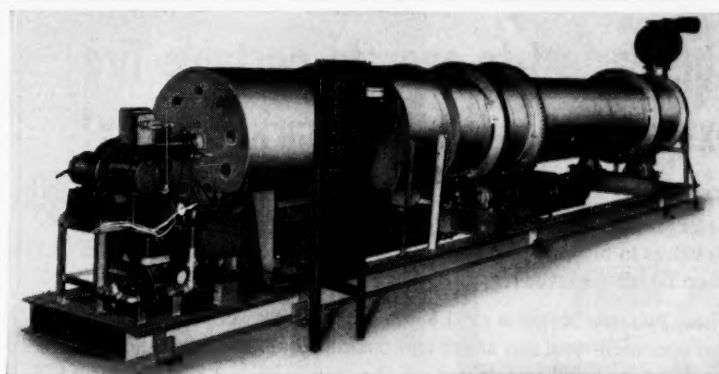
burdens at high operating speeds. Other money-saving features...

- No operating cost. No wiring or power required.
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- High and prolonged surface strength.
- Stainless steel surface for all-weather service.

Write today for more detailed information about how Dings Ceramic Perma Pulleys can up-grade products and prevent tramp iron damage in chemical processing operations.



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A "DAVENPORT" 2'-6" x 16' Rotary Gas Fired Dryer

This compact dryer unit includes the drum, furnace, burner and instruments all assembled on base making an integral installation. Temperature entering this particular dryer is 750° F.

Let our engineers consult with you on your Pressing, Drying and Cooling problems or send for our catalog A. For quick reference consult your Chemical Engineering Catalog.

DAVENPORT MACHINE AND
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DAVENPORT

**PRESSING — DRYING
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COOLING Equipment**

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Presses**

**ROTARY DRYERS
Steam Tube, Hot Air
and Direct Fire**

**Atmospheric
DRUM DRYERS**

**ROTARY COOLERS
Water and Air**

**NEW
FROM
KIDDE!**



2 1/2-gallon
pressurized water

2 1/2-gallon
anti-freeze (loaded stream)

The easiest-to-operate portable fire extinguishers on the market today!

Here, for the first time, is a practical, sensible design for pressurized water and loaded stream extinguishers. No inverting, no bumping, no valves to turn, no pins to pull (safety lock automatically releases when nozzle removed).

These two new stainless steel Kidde portables feature simple, one-two operation—just aim at fire and push the button. Notice the way the hose is stored, safely out of the way. Notice the wide-open handle—to insure fast action even in gloved hands. Notice the dust-and-waterproof pressure gauges—which show at a glance whether the units are fully charged. All of the features—plus the slim design and light weight of these Kidde portables—make them the easiest-to-store, easiest-to-carry, easiest-to-operate portables on the market today.

Approved by Underwriters' Laboratories. Available in pressurized water for fires in ordinary combustibles, or anti-freeze loaded stream for fires in ordinary combustibles and flammable liquids. For more information, write to Kidde today.

Kidde



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1228 Main St., Belleville 9, N. J.

Walter Kidde & Company of Canada Ltd.,
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The words 'Kidde', 'Lux', 'Lux-O-Matic',

'Fyre-Freez' and the Kidde seal are trademarks of Walter Kidde & Company, Inc.

LITERATURE . . .

Automatic De-Sludger offers continuous around-the-clock operation, up to 8000 gph capacity. De-sludging cycle controlled by timing unit. Bulletin gives complete details.
110 *Centrico Inc.

Blowers Capacities of 22 production models range from 50 to 4,000 CFM, pressures to 15 PSIG single, 70 PSIG multi-stage. Full information available.
248A *M-D Blowers, Inc.

Centrifugal, Continuous with 6" dia. bowl is ideal not only for experimental work but for production when order volumes are relatively small.
2 *Bird Machine Co.

Centrifugals Reineveld Horizontal Separators can be opened, thoroughly cleaned & inspected in 1/2 hour. Sanitary operation at all times. Bulletin 356.
TL263 *Heyl & Patterson, Inc.

Centrifuge Information is now available on the AC-VO "Nozzle-Matic" Centrifuge and the different types of solids concentrators that can solve your problems.
28-29c *De Laval Separator Co.

Dryer Unit Rotary Gas Fired Dryer includes the drum, furnace, burner and instruments all assembled on base making an integral installation. Catalog.
BL247 *Davenport Machine & Foundry

Dust Collector The new Model B AMERjet features fewer filter bags, super rugged drive, modular design, and greatly reduced space requirement. Bulletin 279C.
120 *American Air Filter Co.

Filter Durco-Enzinger features finger leaf spacers, wingwheel closure, tilting leaves, oscillating sluice, traveling sluice & cake thickness detector. Bul. EF/2a.
197 *The Durrin Company, Inc.

Filter The Eimco belt continuous belt drum filter can handle even the most difficult slurries. The filter medium is always clean. Bulletin F-2053.
Cover *The EIMCO Corp.

Filter, Duplex can lengthen the service life of your valuable equipment . . . reduce downtime . . . cut maintenance costs. It keeps lube oil clean. Information.
215 *Wm. W. Nugent & Co., Inc.

Filter, Retractable Shell is designed for filtering under pressure. Pressures up to 100 psig, sizes to 3000 sq. ft. Complete information available.
261 *Goslin-Birmingham Mfg. Co.

Filters Process Filters make available pilot plant test filters. Data folders: "Batch Recovery", "High Solids Removal", or "Polish Filters" are offered.
113 *Bowser Inc.

IMP Mill Catalog No. 87 shows the many applications of this multi-purpose unit . . . and how it can be adapted to your pulverizing job. Available now.
148 *Combustion Engineering, Inc.

Kilns & Slakers feature advanced design for operating economy. In daily use by the processing industries. Additional information in Bulletin No. 1115.
32 *Traylor Engineering & Mfg. Co.

*From advertisement, this issue

the CENTRIFUGE for Top Performance

Sold and Serviced by
HEYL & PATTERSON

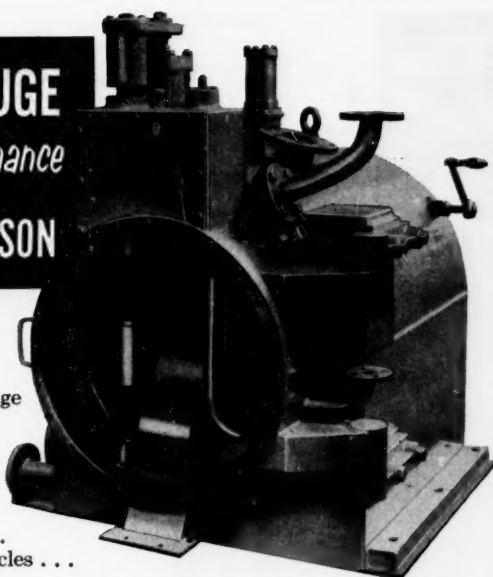
REINEVELD Centrifuge of special stainless steel construction and control design assures high purity of pharmaceutical grade crystals. Variable speed drive . . . Automatic operating cycles . . . Vapor-tight housing.

Reinevels, available with G-forces up to 2000 are used for de-watering and washing of crystals and for the separation and clarification of amorphous slurries.

Consult our listing in CEC or write for bulletin 356

HEYL & PATTERSON, inc.

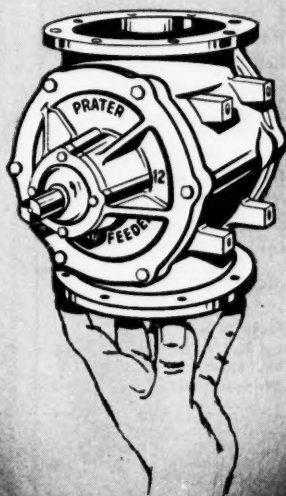
55 FORT PITT BLVD., PITTSBURGH 22, PA.



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for
DUST CONTROL
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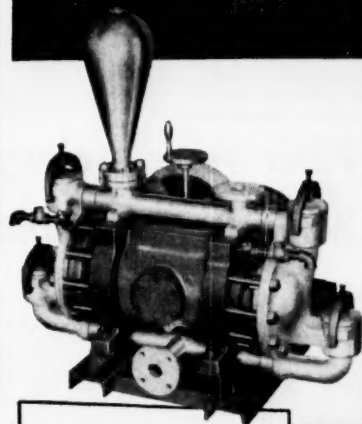
WRITE FOR BULLETIN P58

PRATER PULVERIZER COMPANY

1517 South 55th Court • Chicago 50, Illinois

for those hard-to-handle fluids

- CORROSIVE
- ABRASIVE
- VISCOUS
- THICK
- HEAVY
- QUICK SETTLING
- VALUABLE
- SENSITIVE
- HAZARDOUS



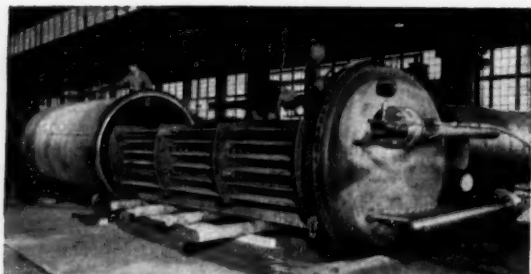
SHRIVER DIAPHRAGM PUMP

- LOW OPERATING COST
- LOW MAINTENANCE COST
- LONGER SERVICE LIFE
- EASY TO CLEAN

Thousands of Shriver pumps handling materials that clog or wear out other pumps all too quickly have proved their amazing service economy record. It will pay you to get Bulletin 148.

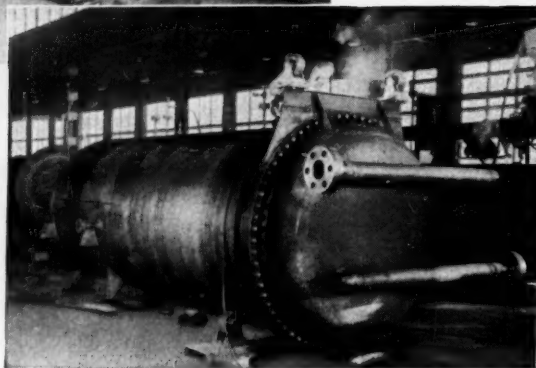
T. SHRIVER & CO., Inc.

802 Hamilton St., Harrison, N. J.



View showing how tube bundle slides out for ease of cleaning.

Vilter Synthesis Heat Recovery unit for Canadian chemical plant. Rollers being welded in place.



Vilter Vessel Salvages "Waste Heat" While Desuperheating Ammonia Gas!

This Vilter synthesis heat recovery unit makes every BTU do double duty. Using waste heat from mixed synthesis and ammonia gas, this vessel vaporizes water at 45 psi to steam at the rate of 6640 pounds per hour. In the process the gas at 4800 psig is cooled from 495° F. to 328° F. The steam is then used in other plant operations.

This Vilter unit weighing 15 tons is 72" in diameter, 17' long, and has 1150 lineal feet of tubing. Croloy tubing and headers are used because at temperatures over 500° F. carbon steel would be de-carbonized by the nitrogen-hydrogen mixture. Shell and cover are of welded steel for tightness and strength. For easy cleaning, the "U" tube bundle slides out on rollers. This heat recovery unit is typical of the custom work Vilter is doing in the field of heat exchangers and pressure vessels to meet design and budget requirements.

Vilter can give you the most efficient heat exchanger equipment with working pressures as high as 10,000 psi. Vessels are built in conformance to the A.S.M.E. Code and when specified to T.E.M.A. standards.

Consult with Vilter for your special vessel needs.

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Air Units • Ammonia & Freon Compressors • Booster Compressors • Soudelot Coolers • Water & Brine Coolers • Blast Freezers • Evaporative & Shell & Tube Condensers • Pipe Coils • Valves & Fittings • Pakice & Polarflake Ice Machines

Bulletin 827
Vilter Industrial
Heat Exchangers



LITERATURE . . .

Line Strainers.....for Spray Nozzle systems and related systems are covered in Bulletin 94. Available in stainless steel, cast iron and brass.

B224 *Spraying Systems Co.

Magnetic Pulley.....Detailed information about how new Ceramic Perma Pulleys can up-grade products & prevent tramp iron damage in chemical processing operations.

TL247 *Dings Magnetic Separator Co.

Mills, Colloid.....Brochure discusses colloid mills with new design features. Capacities from 1 to 125 hp. Materials of construction of semi and stainless steel.

250A Chemicolloid Labs, Inc.

Mills, Hammer.....feature extra heavy manganese steel liners & breaker plates, oversize shafts, massive parts & reinforcements. Catalog is available.

137 *Williams Patent Crusher

Mixers.....in 6 standard models, 1 to 200 HP. Special units to 500 HP. Available with horizontal or vertical motor drive, with paddle or turbine type impellers. Cat. A-19.

4 *Philadelphia Gear Corp.

Pelletizing Machinery.....Unique, new simplified design. Special stationary die, horizontal head. Alloy construction as desired. Additional information in Bul. L-109.

T224 *Daffin Mfg. Co.

Process Equipment.....Catalog offers details on vacuum dryers, blenders & mixers, ball mills, impregnators, vacuum pumps, jacketed valves, code design, fabrications, etc.

C247 *J. P. Devine Mfg. Co.

Process Equipment.....Kilns for lime, calcined coke, dead burned bauxite, cement by wet or dry process, nodulizing & agglomerating or drying.

175 *Kennedy Van Saun

Process Equipment.....Catalog describes and illustrates the manufacturer's line of heat transfer equipment, reactors, mixers, kettles and special machinery.

250B Manning & Lewis Engineering

Processing Equipment.....converts fines to high quality granules. Includes compacting mill, roller mill and vibrating screen. More information in Bulletin 7B8836.

237 *Allis-Chalmers

Processor.....The Holo-Flite is a simpler, more compact way to cool, heat or dry—in a continuous flow. An 8-pg. bulletin describes its features & applications.

97 *Western Precipitation Corp.

Pulverizer.....The Type B Pulverizer is reversible, designed for heavy duty work, is dust-tight, & has hydraulic adjustments. Complete information.

50 *The Jeffrey Mfg. Co.

Rotary Airlock Feeders.....Complete information on Rotary Airlock Feeders for dust control and pneumatic conveying contained in Bulletin P 58.

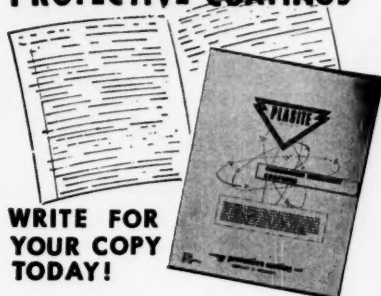
BL249 *Prater Pulverizer Co.

Scrubber, Venturi.....New type SF facilitates handling of scrubbing liquids containing large lumps, heavy solid concentrations or solutions likely to scale heavily.

57 *Chemical Construction Corp.

*From advertisement, this issue

Simplify YOUR SELECTION OF PROTECTIVE COATINGS



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- STEEL TANK LINING
- CONCRETE TANK LINING
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- CONCRETE FLOORS
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HEAVY BUILD using standard
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WIDE CHEMICAL RESISTANCE
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HIGH TEMPERATURE RESIST-
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EXCELLENT BOND — No Primers
on white metal blasted
surface.

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BAKING COATINGS

WISCONSIN
**protective
coating**
COMPANY GREEN BAY, WIS.
REPRESENTED IN PRINCIPAL INDUSTRIAL AREAS

PLASITE

LITERATURE . . .

Separators. . . . Available in carbon or stainless steel, the Syncro-Matic may be obtained with from 1 to 3 decks, & a full range of screen meshes & materials. Details. 28-29b *De Laval Separator Co.

Strainers, Pipe Line. . . . Screwed, 1/4" to 3"; pressures to 600 psi. Socket-weld, 1/4" to 3", pressures 600 & 1500 psi. Flanged, 1/2" to 5", pressures to 600 psi. Bul. S-205. 59 *Yarnall-Waring Co.

Pumps, Fans, Compressors

Air Handling System. . . . Illustrated brochure outlines the benefits, features and components of a Fluidizer system. Also describes Fluidizer valves. 251B The Fluidizer Company

Centrifugal Compressors. . . . New literature describes three styles of single-stage, scroll-casting compressors. Impeller chart, performance data and seal arrangements. 251B Allis-Chalmers Mfg. Co.

Compressors. . . . Diaphragm type compressors have no contact between gas & hydraulic fluid; gases are compressed between hydraulically-pulsed diaphragms. Bulletin 4071-C. BL245 *American Instrument Co., Inc.

Pump. . . . Bulletin 500-A contains a complete description & specifications on the new Auto-Pneumatic Microflo Pulsafeeder. Four models are available. 187 *Lapp Insulator Co., Inc.

Pump. . . . The chemical positive displacement pump incorporates many outstanding features such as twin-balanced impellers, self-priming, etc. Catalog P 302. 177 *Waukesha Foundry Co.

Pump, Diaphragm. . . . for those hard-to-handle fluids; corrosive, abrasive, viscous, thick, heavy, etc. Easy to clean. Bulletin 148 is available on request. R249 *T. Shriver & Co., Inc.

Pump, Gear. . . . Improved design . . . now 12 gpm. All wetted parts acid-resistant, wear-resistant Ace hard rubber. Complete information in Bul. CE-55. 211b *American Hard Rubber Co.

Pumps. . . . Horizontal Triplex pumps handle large volume of all types & densities of fluid. Capacities from 50 to 6500 GPH . . . pressures from 500 to 12,000 psi. Bul. P-55. 107 *Manton Gaulin Mfg. Co.

Pumps. . . . "Karbate" centrifugal pumps feature rugged construction, unsurpassed corrosion resistance, wide range of models & sizes, interchangeable parts, etc. 33-36 *National Carbon Company

Pumps, Centrifugal. . . . Type OJ are ideal for municipal or industrial water service for line pressure buildup, boosting to pressure tanks or elevated tanks, etc. Bul. 105-B. 229 *N. Y. Air Brake, Aurora Pump

Pumps, Chemical Feed. . . . New 200 Series Simplex model can pump up to 812 gph. Duplex model has double this capacity. Maximum pressure of 10,000 psi. Details. 216 *American Meter Co.

* From advertisement, this issue

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MEASURES
UP TO...**

VITREOSIL®

FOR THERMAL SHOCK RESISTANCE,
CHEMICAL INERTNESS IN TUBING



Sand-surfaced, glazed or satin-surfaced and transparent . . . in all normal lengths and diameters. Homogeneous, transparent, free from chemical impurities. Useful to 1000°C.

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Non-absorbent, non-catalytic, non-porous, immune to extreme electrical, thermal and chemical conditions. Many sizes and types in stock. Prompt delivery for special sizes.

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pervious to all organic
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gardless of concentration
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Catalog.



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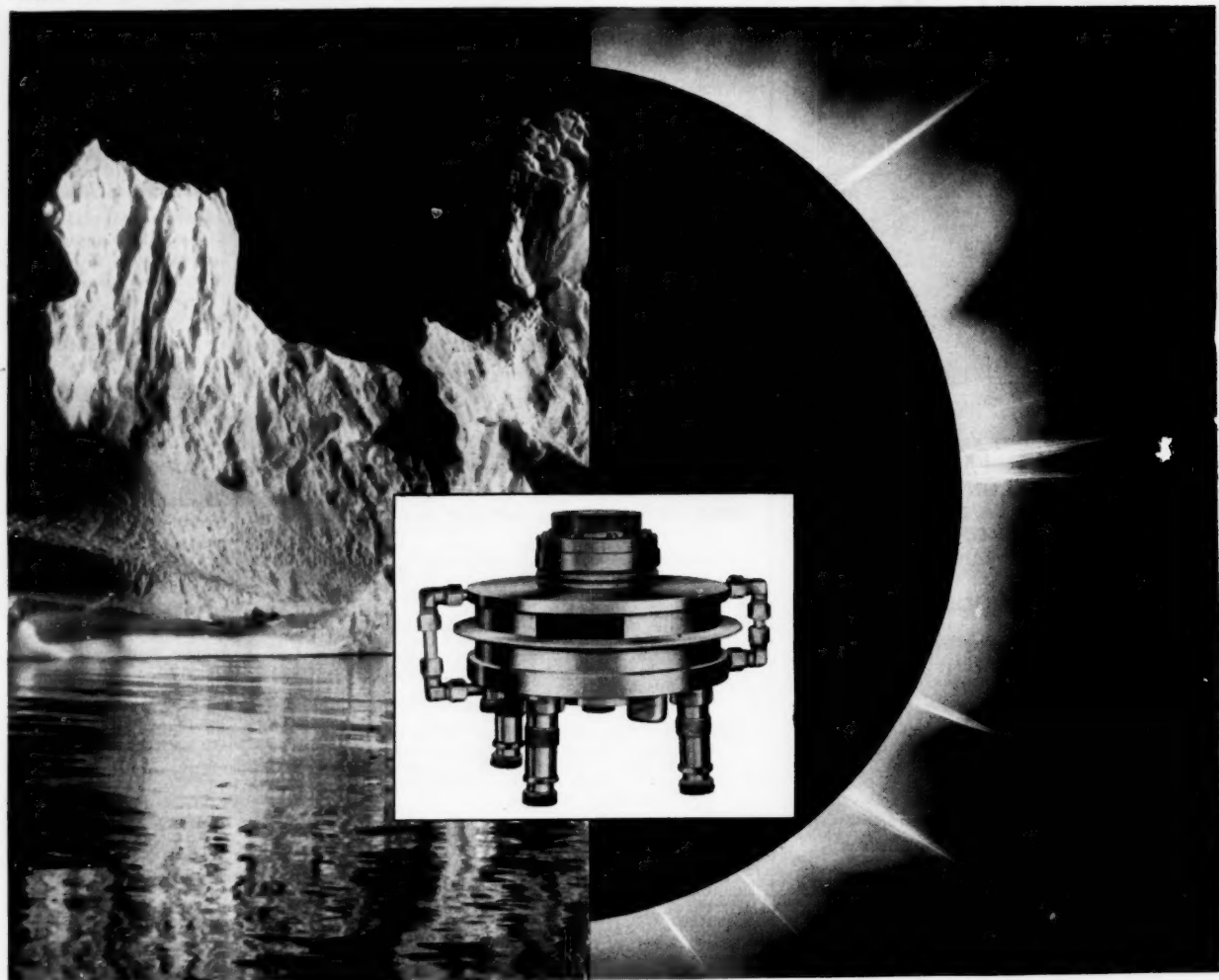
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THE RAW MATERIALS OF PROGRESS



FLUOROchemicals, STABLE BELOW 0°

When extremes are the norm, inert fluids tame many problems. Fluorochemical FC 75, a 3M inert fluid, was specified for use in cooling the RCA transmitting tube shown above—a beam power tube capable of delivering a useful cw power output of 25 kw at 400 Mc. FC 75 permitted design of the tube for operation at temperatures below 32°F. with essentially the same power output as that obtained with water cooling at temperatures above

32°F. The most stable fluid ever developed, the properties of FC 75 have outstanding value in electronics, where it serves as a coolant and insulating fluid. Even under extended use at high voltage FC 75 maintains high dielectric strength. It has wide liquid range, from -148°F. to 212°F., with low viscosity. Nontoxic, non-flammable, it is thermally stable in excess of 800°F. Get all the facts about this "do nothing" chemical. See what FC 75 can do for you.

CHEMICAL DIVISION

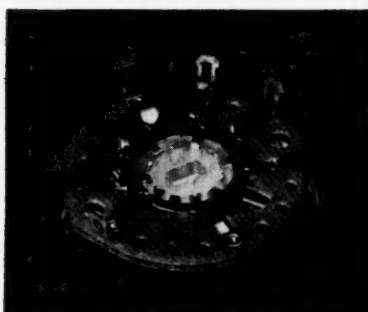
MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW





CUTS CORONA CRACKING Furatone NC-1008, added to neoprene compound ignition cable jackets made by Belden Manufacturing Company, almost eliminates corona cracking, as seen in this comparison of two types of jackets. The new Furatone NC-1008 compound cuts raw materials cost by as much as 8%, reduces scrap waste by 50%, improves processing.



ROTARY SWITCH SIZE REDUCED! Plastic rotors, made by Oak Manufacturing Company of KEL-F® halofluorocarbon, made possible the development of a smaller rotary switch only $1\frac{1}{2}$ " in diameter. The zero moisture absorption, high dielectric strength, low co-efficient of friction of the KEL-F rotor aided in miniaturization. KEL-F is chemically inert, resists thermal shock, has high impact strength.

or at 800° F.

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• Oils, Waxes and Greases • Dispersion
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• Inert Liquids and Surfactants.

LITERATURE . . .

Services & Miscellaneous

Chemical Marketing.....problems in the 1960s are forecast in a new book which can now be purchased. Collection of papers presented at ACS meeting in Sept. 1959.

213-4n *U.S. Industrial Chemicals Co.

Filtration.....Cellite has the exact grade for every filtration need from fast flow rate to maximum clarity. Information on specific filtration or mineral filler problems.

114 *Johns-Manville

Fire Extinguishing System.....for small, hard-to-protect areas has been developed. Uses high pressure liquid CO₂ in easily stored cylinders. Details in No. 1543.

213-4h *U.S. Industrial Chemicals Co.

Industrial Foaming.....Treatment of problems with silicones described in bulletin. Discusses causes of foaming, control methods, selection of proper defoamer, etc.

213-4f *U.S. Industrial Chemicals Co.

Iron Equipment.....Catalog A-9 contains complete information on blinds, spacer rings, temporary & line strainers & pivot flanges. Available on request.

R247 *The Mack Iron Works Co.

Marking & Decorating Ink.....for treated or untreated polyethylene is now available. Said to remain permanently flexible and does not chip when flexed. No. 1545.

213-4j *U.S. Industrial Chemicals Co.

Package Plants.....producing oxygen & nitrogen simultaneously plus a new type package Refrigeration Unit. Available in large & small sizes. Information available.

205 *Independent Engineering Co., Inc.

Photochemical Equipment.....A valuable & informative brochure "Photo-Sensitization" contains complete information on process & applications.

24-25c *Engelhard Industries, Inc.

Plant Layout Models.....Catalog describes the uses and savings that can be realized on utilization of models in plant layout work. All phases of model design shown.

253A Visual Plant Layouts, Inc.

Polyethylene Boots.....Disposable boots for technicians in biological & atomic laboratories, where spreading of contamination is a problem, are now available.

213-4e *U.S. Industrial Chemicals Co.

Portable Fire Extinguishers.....feature simple, one-two operation, wide open handle insures fast action, dust- and - waterproof pressure gauges, etc. Information.

248 *Walter Kidde & Co., Inc.

Process Plants.....Long experience with basic processing methods such as fluidized solids, effluent refrigeration, etc. New full-illustrated booklet describes services.

181 *Foster Wheeler

Rocket Propellants.....are covered in detail in new 224-pg. book now being sold. Contents include composition, production, performance for solid or liquid systems, etc.

213-4i *U.S. Industrial Chemicals Co.

*From advertisement, this issue

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Chlorine—Soda Ash—Perchloroethylene
Pigments and Related Products
Design—Reports—Operation

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Akron, Ohio

Tele: Akron, O. TE 64271

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By reason of special training, wide experience and tested ability, coupled with professional integrity, brings to his client detached engineering and economic advice that rises above local limitations and encompasses the availability of all modern developments in the fields where he practices as an expert.

CLASSIFIED . . .

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CE's nation-wide coverage brings you tips and information on current opportunities in job functions throughout the chemical process industries.

► **Coverage** — National Executive, management, engineering, technical, sales, office, skilled. Positions vacant, positions wanted, civil service, selling opportunities, employment agencies and services, labor bureaus.
► **Displayed Rates**—\$54 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured $\frac{1}{8}$ in. vertically on a column; 3 columns, 30 in. per page. Subject to the usual agency commission.

► **Undisplayed Rates**—\$2.10 per line, 3 lines minimum. To figure advance payment count 5 average words as a line; box number counts as 1 line, 10% discount if full payment is made in advance for 4 consecutive insertions. Not subject to agency commission.

► **Closing Date** — January 11th issue closes, December 18th. Send new ads to Chemical Engineering, P. O. Box 12, New York 36, N. Y.

CHEMICAL, PETROLEUM OR POWER ENGINEERS

The Foxboro Company is adding to its group of staff sales engineers to keep pace with its steadily increasing share of the industrial instrumentation industry market. Men needed should be graduate engineers with several years of instrumentation or process control experience in the chemical, petroleum, gas or power industries. You must be sales minded and should enjoy working with our customers and sales personnel. If you feel qualified for one of these challenging career opportunities send a letter and resume to:

Engineering Recruitment Office

FOXBORO
REG. U.S. PAT. OFF.

The Foxboro Company, Foxboro, Mass.

PROCESS ENGINEERS

Permanent opportunities are available at our Cleveland offices for Chemical Engineers experienced in Process Design for Petroleum and Chemical Plants.

Send detailed resume to:

G. VICTOR HOPKINS

ARTHUR G. MCKEE & CO.

2300 Chester Ave., Cleveland 1, Ohio

PROCESS ENGINEER

Consolidated Water Power & Paper Company is considering applications for the position of Process Engineer.

Our Process Engineers are part of the mill technical staff and operate as an integral part of production on problems involving quality control, wastes and efficiencies. These Engineers are assigned to specific areas in the mill such as Groundwood Pulping, Stock Blending, Papermaking and Coating, and are expected to provide guidance and technical advice to the operating personnel.

This Process Engineer should have an educational background in Paper Technology, Chemistry, or Chemical Engineering.

Two or three years experience in Process Engineering or mill technical service work in Groundwood Pulping, Chemical Pulping, and/or wet-end machine trials is necessary.

This position is located in Central Wisconsin.

Please send resume and application for interview to L. J. Barrette, Director of Personnel & Labor Relations, Consolidated Water Power & Paper Company, Wisconsin Rapids, Wisconsin.

SPECIFICATIONS WRITER

BUTLER MANUFACTURING COMPANY, MULTI-PLANT WORLD LEADER in manufacture and sale of a broad line of pre-engineered buildings and other durable capital equipment seeking capable Specifications Writer to prepare material specifications for metals, plastics and components used in the manufacture of pre-engineered buildings. Employment in headquarters Engineering Department of Buildings Division. College training in Chemical, Mechanical or Civil Engineering preferred. Experience in and familiarity with ASTM and Commercial Standards and Federal Specifications desirable. Considerable knowledge of metallurgy and metals needed.

Salary in line with experience and ability. Advancement by merit. Residence in corporate headquarters city, Kansas City, Missouri. Progressive and liberal compensation and benefit plans. Send full information on personal and work history to Mr. Orval W. Groves, Employment Supervisor, 7400 East 13th Street, Kansas City 26, Missouri. BUTLER MANUFACTURING COMPANY

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We are expanding our Sales Department and require Engineers, with two or three years' industrial experience after finishing college, for Chicago, St. Louis, Houston, and Baltimore.

Trainees will receive three months' classroom instruction at factory before they are assigned to a District Office as a Sales Engineer. Excellent opportunity with fast-growing company.

Address reply to Mr. H. E. Beane, Vice Pres.,
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Exclusive territory, to sell mixers, colloid mills and process equipment to food, chemical, petroleum, paint and similar industries. Will turn over accounts and leads. Backed by extensive advertising campaign and Trade Shows. Full training. Give full details first letter.

RW-2977 Chemical Engineering
Class Adv. Div., P.O. Box 12, N. Y. 36, N. Y.

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Send to office nearest you.
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CHICAGO 11: 529 N. Michigan Ave.
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Chemical or Mechanical Engineer, Eastern
U.S. Manufacturer requires experienced Engineer for Process and Mechanical Design of Fired Heaters. Age 30-40. Minimum Experience—5 years. Ch.E. or M.E. degree preferred. All replies will be treated confidentially. P-2972, Chemical Engineering.

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Need commission salesmen?—To sell your products or to solicit contract work. We have them for you—32,000 proven commission sales agents. Albee-Campbell, Inc.,—National Clearing House for Manufacturers agents. New Canaan, Conn. Tel WO 6-4233.

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Better Positions—\$6,000 to \$50,000. Want a substantial salary increase more opportunity or different location? This national 48 year old service connects you with best openings. You pay us only nominal fee for negotiations; this we refund when employer pays placement fee. Present position protected. In complete confidence, write for particulars. R. W. Bixby, Inc., 553 Brisbane Bldg., Buffalo 3, N. Y.

"Put Yourself in the
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**TO EMPLOYERS
TO EMPLOYEES**

Letters written offering Employment or applying for same are written with the hope of satisfying a current need. An answer, regardless of whether it is favorable or not, is usually expected.

MR. EMPLOYER, won't you remove the mystery about the status of an employee's application by acknowledging all applicants and not just the promising candidates.

MR. EMPLOYEE you, too, can help by acknowledging applications and job offers. This would encourage more companies to answer position wanted ads in this section.

We make this suggestion in a spirit of helpful cooperation between employers and employees.

This section will be the more useful to all as a result of this consideration.

Classified Advertising Division

McGraw-Hill Publishing Co., Inc.

330 West 42nd St., New York 36, N. Y.

Need a RESIN PLANT?

We offer **DESIGN & CONSULTING SERVICES** for the following type plants:—

ACRYLIC EMULSION Plants
POLYVINYL ACETATE Emulsion Plants
PHENOLIC RESIN Plants
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 — and many others —

DESIGN & CONSULTING DIVISION of
Star Tank & Filter Corp.
 871 Edgewater Rd. N. Y. 59, N. Y.

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 Send to office nearest you.
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BUSINESS OPPORTUNITIES

Capital available for well managed companies in electronics, chemical or related fields in need of funds for growth. Must have established record of at least 2-3 years with interesting future prospects. BO-3125, Chemical Engineering.

Wanted: Unique formula, product or industrial method. Successful marketing organization is ready to invest capital and manpower! Write for interview. BO-3180, Chemical Engineering.

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 600 HP Syn 3-60-2300

AMERICAN AIR COMPRESSOR CORP.
 North Bergen, N. J. UNion 5-4848

- 1 Sparkler Filter Mod 33-S-14, all SS w/mild steel steam jacket.
- 2 Foster Wheeler SS Bubble Cap Columns, 96" dia, 28 trays, w/headers and condensers.
- 1 Mojonier Vae Pan 6' dia, 153 sq ft heating surface, all SS.
- 1 Baker-Perkins Mixer, size 17 DAM, dbl sigma, 200 gal wc, 80 HP.
- 1 Peerless Mixer, 100 gal wc, dbl sigma blades.
- 1 Sprout-Waldron 105 cu ft Ribbon Blender.



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AARON EQUIPMENT CO.

9370 Byron Street
 Schiller Park, Illinois
 Gladstone 1-1500

2-5' x 8' BALL TUBE MILLS

2-5' x 8' Kennedy Van Saun Air Swept Ball Tube Mills with disc feeders, fans, piping, all motors and electric eye mill level controls.

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500,000 ft 10 1/2" O.D. 35#
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All Machine Cleaned. Plain end. No. 1 Grade.
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CE's Searchlight spots the big bargains in used, resale and rental equipment. Check this issue's listings—most complete in the field—for items you need now

► **Coverage** — National Equipment and facilities—used, resale and rental—for the process industries. For sale, wanted, for rent.

► **Rates**—\$21.75 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured 1/4 in.

vertically on a column; 3 columns, 30 in. per page. Ads acceptable only in display style.

► **Closing date** — January 11th issue closes December 18th. Send all new ads to Chemical Engineering, Classified Adv. Division, P. O. Box 12, New York 36, N. Y.

FOR "IMPOSSIBLE" BUDGETS

OUR TERMS MAKE THESE EASY TO BUY

- 1—Sharples C-20 Super Dehydrator type 316 S.S. 20 HP Mtr & Timer
- 1—Fletcher 40" Perf. Basket Centrifuge. Type 316 S.S. 25/12 1/2 HP
- 2—Sweetland #2 Filters, with 18 leaves on 2" centers
- 3—Ingersoll-Rand Vac. Pumps. 2—22 x 9 and 1—26 x 11, type E51

- 1—Raymond #0 Auto. Pulverizer. With 6' Dbl. Whizzer Separator
- 3—Eimco 8' x 14' Rot. Vac. Cont. Filters. Closed steel drum
- 1—Krenz 4-Effect Copper Evaporator, Colandria type, 8000 sq ft
- 2—Standard Steel Rot. Dryers. 5' x 47' & 70' x 50'. Complete

For immediate quote, wire or phone collect—GA 1-1380



MACHINERY AND EQUIPMENT COMPANY

123 Townsend St. - San Francisco 7, California

LOEB OFFERINGS

Autoclave: 50 gal. Struthers Wells, st. st. Centrifugal: Tolhurst 20" st. steel (New).
 Dewaterers: Davenport 3A, bronze hd. 3 hp.
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 Dryers: Devine 2 x 4' vac. drum, st. steel.
 Dryer: Bowen lab. spray st. steel.
 Dryer: Louisville 30' steam tube.
 Evaporator: Bullovak st. st. 94 sq. ft.
 Homogenizers-Disperser: Tri-Homo 210, 224.
 Kettles: St. Steel, with and without ag.
 Dopp 150 gal. dbl. act. agitator.
 Mills: Mikro Bantam, ISH.
 Fitz Comminuting model D, st. st.
 Colloid, 3, 5, 20, 25 hp.
 Cog stain. steel, 10 hp.
 Hammer: Williams, Jeffery, Prater, Ray.
 Mixers: Dbl. and Sgl. arms sigma blade.
 Dry Powder, various sizes.
 Baker-Perkins size 17, 30 hp.
 Mix-Muller Simpson 18" lab., 39 1/2" Porto.
 Perculator: Pfaudler 54 x 42" st. st. jack.
 Pumps: Rotary, gear, centrif., vacuum.
 Screen: Rorex model 41 st. steel.
 Still: Double effect st. st. 11.83 gal.
 Tablet Press: Stokes DD2, 23 station.
 Vacuum Pan: 42" Harris st. steel.

LOEB EQUIPMENT SUPPLY CO.
 820 WEST SUPERIOR ST. CHICAGO 22, ILLINOIS

BALL MILLS—3' x 12' Abbe/40 HP—4' x 6' Allis Chalmers 60 HP Slip Ring/screwfeeder—Kennedy Van Saun 5' x 6' Enclosed gears/30 HP/scales/feeders/exhausters—Hardinge 6' x 12' w/200 HP Slip Ring/drum feeder.

HAMMERMILLS—20 HP Gruendler X—30 HP Mikro 3W—40 HP Jeffrey 24 x 20—50 HP Wms. AKBX—100 HP Jeffrey 36 x 42—450 HP Penna SXT 14.

ROTARY DRYERS—24" x 22"—36" x 24"—44" x 25"—5' x 50' (2) all w/motor drives—burners/blowers avail.

VACUUM PUMPS—115 CFM Beach Russ 100 HP w/5 HP motor/Vee belt drive.

SCALES—12500# capacity dial—Fairbanks Platform—8' x 6' Platform.

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YOUR BEST REBUILT MACHINERY SOURCE

LAWLER COMPANY

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Sell us your idle or surplus **EQUIPMENT** for **CASH** or replacement units. For Tax "Write offs" for a fresh new start in your production lines **NOW** is the time to clear the decks. The list below gives you an index of the items **FMC** will buy or sell. Let's **TRADE. SEND US YOUR LIST OF SURPLUS.**

Agitators	Juice Extractors
Attrition Mills	Kettles
Autoclaves	Kilns
Ball Mills	Labelers
Blenders	Mills
Bucket Elevators	Mixers
Calendars	Ovens
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Glue-Sealers	Pug Mills
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Centrifugals	Pulverizers
Clarifiers	Pumps
Coating Pans	Presses
Colloid Mills	Pressure Vessels
Columns	Reactors
Compressors	Retorts
Conveyors	Roll Mills
Cookers	Rubber Mills
Coolers	Screens
Crushers	Sifters
Crutchers	Slitters
Crystallizers	Spray Dryers
Dryers	Sterilizers
Evaporators	Still
Expellers	Tablet Presses
Extruders	Tube Fillers
Fillers	Tumbling Mixers
Filter Presses	Vacuum Dryers
Grinders	Vacuum Fillers
Hammermills	Vacuum Filters
Heat Exchangers	Vacuum Pans
Homogenizers	Viscolizers
Hydraulic Presses	Vulcanizers
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FIRST MACHINERY CORP.

209-289 TENTH ST.
BROOKLYN 13, N. Y.
Sterling 8-4672

MODERN REBUILT MACHINERY

Stokes 90-D Automatic Stainless Steel Tube Filler and Closer.
Colton Model 177F and Stokes Model 90D Automatic Tube Fillers and Closers.
Colton Model 140 Single Head S.S. Tube Filler.
Pneumatic Scale High Speed Automatic Cartoning Line with Feeder, Bottom Sealer, Top Sealer, Wax Liner, Interconnecting conveyors.
Standard Knapp, A-B-C, Ferguson and Ceco Case Sealers.
WRAPPERS: Package Machinery, Hayssen, Battle Creek, Scandia, Wrap-King all sizes and models.
Stokes & Smith Model DD-2 Rotary Tablet Machine.
Baker Perkins Model JNM Size 14, 50 gal., S.S. Jacketed Mixer.
Werner & Pfleiderer 3,000 gal. and 3,500 gal. Jacketed Double Arm Mixers.
Baker Perkins, Day, W. & P. Heavy Duty Mixers, 12 to 150 gal. caps.
Colton 6 ft. diam. S.S. Revolving Pan.
Stokes & Smith Model G1, G2, G4, HG84, HG87 and HG88 Auger Powder Fillers.
Mikro Pulverizers, 15H, 2TH, 3TH and 4TH.
Fitzpatrick Stainless Steel Comminutors.

Complete Details and Quotations
Available on Request

UNION STANDARD EQUIPMENT CO.

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CAnal 6-5333

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FEATURED ITEMS

2300 gal. 304 S.S. Tank
Fletcher 30" Susp. S.S. 10/5 H.P. Centrif.
Fletcher 40" Susp. Steel Centrif.
Oliver 5'3"x3' Stainless Precoat Filters
Nooter 750 gal. Steel Reactor 300 PSI
Link Belt 502-16 Roto-Louvre Dryer
8'x80' Rotary Dryer 316 S.S.
Vulcan 9'x100' Rotary Kiln
5'x45' Standard Rotary Dryer
Moesser 4'x47' Rotary Dryers
Louisville 6'x50' Steam Tube Dryer
Traylor 8'x11' Ballpeb Mill
Condensers, Exchangers 100 to 5000 sq. ft.
Stainless Admiralty Steel
Pressure Vessels 300 to 4500 gal.
Towers and Columns 3' to 10' Dia.

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BEST BUY

2-BUCKET ELEVATORS

Link-Belt Double Chain with 18" x 8" Buckets on 12" centers. 54" x 28" single Case. 7-1/2 HP Gear Motor drive
EXCELLENT CONDITION

Wire or phone collect—GA 1-1380

ME MACHINERY & EQUIPMENT CO.

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MACHINECRAFT

S. S. Reactor 1200 gal 200 lb pressure
Baker Perkins 150 gal 40 HP, 100 gal 50 HP
both S.S. 2 arm jacketed vacuum hydr. tilt
Blaw-Knox 2 gal S.S. Autoclave 5000 lbs.
50 gal S.S. Autoclave 2000 lbs pressure
3 1/2 gal. S.S. Autoclave, 2000 lbs. pressure
Vulcanizer 60" x 9' 125 lbs.
Sweetland #2 all stainless
Stainless steel Ball Mill
Aluminum Condenser 350 sq. feet
Aluminum Evaporator Calandria type, never used.
1300 sq. ft. tube area.
Pretor & Schwartz Rinned drum driers
Continuous Stripping column 2 X 13 Steel
Calenders 3 Roll 45" X 18"; 6 Roll 12" X 5"
Hydraulic Pumps, Motors.

LOUIS SUSSMAN, INC.

800 Wilson Ave. (East of Doremus)
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Baker-Perkins 150 Gallon Model 15 U S E S.S. Mixer

Complete with vacuum cover, 75 HP motor and compensator starter. Unit now disassembled and will be completely rebuilt.

BERKSHIRE COLOR CO. INC.

12th & Barn Streets, Reading, Penna.
Telephone Franklin 3-4178 Collect

FOR SALE

ELECTRIC HOT-PACK CO. CABINET

24 x 20 x 30—Temp. range 30°—180° C
Stainless Interior. Serial 46416—115 V.
Write

FS-3158, Chemical Engineering
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

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No charge or obligation

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used equipment not currently advertised. (This service is for USER-BUYERS only.)

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

Searchlight Equipment Locating Service

Classified Advertising Division
CHEMICAL ENGINEERING

P. O. BOX 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service
Classified Advertising Division
CHEMICAL ENGINEERING
P. O. Box 12, N. Y. 36, N. Y.

Please help us locate the following:

NAME
TITLE
COMPANY
STREET
CITY ZONE
STATE 12/14/59

LIQUIDATION

TITANIUM DIOXIDE PLANT BALTIMORE, MD.

CENT.—FILTERS—EVAPS.—CRYSTAL

- 1—Bird 32" x 50" Cent. Cent. 316 S.S.
- 4—Sharples C20 Super D-Hydrators, 316 S.S.
- 1—Sharples PN14 Super-D-Canter, 316 S.S.
- 1—AT&M 26" sus. Cent., perf. bskt., 316 S.S.
- 1—Oliver 8' x 8' Precoat rubber covered Rotary Vacuum Filter.
- 5—Sperry 36" plate & frame Filters, rubber covered, cast iron, and wood.
- 5—8' dia. x 24' rubber lined Crystallizers.

PULVERIZERS AND MILLS

- 2—Abbe 5' x 16' brick lined Mills.
- 2—30" dia. Stainless Steel Micronizers complete with Hoppers, Conveyors, etc.

ROTARY KILNS

- 1—Traylor 11' x 155' Rotary Kiln, 7/8" shell.
- 1—Renn. 6' x 60' Rotary Kiln, 5/8" shell.

RUBBER LINED TANKS

- 5—8500 gal. Vertical Storage 8'6" x 16' x 8' cone.
- 1—23,000 gal. Horizontal Storage 8' x 35'.

STEEL TANKS

- 6—2000 to 5200 gal. with Turbo Agitators.
- 15—Storage Tanks: 3800; 6000; 9000; 10,000; 15,000; 47,000 gals.

MISCELLANEOUS

- 7—Dorr Thickeners: 16' dia. with Tanks.
- 1—Bemis 50# Bag Packer with Sewing Machine, Conveyor and Flatteners.
- 58—LaBour, Durco, Warwhite, Duriron and Stainless Steel Centrifugal Pumps 2" to 6" with motors.

Representatives on premises,
2701 Broening Highway, Baltimore, Md.
Telephone: Medford 3-2911

BRILL EQUIPMENT CO.
35 Jabez Street,
Newark 5, N. J.
Tel: Market 3-7420

ECH SPECIAL

Baker Perkins Mixer, serial #40722, double arm, cored sigma blades, size (15-V1) M-BS 100 gal. working, jkt. on 4 sides, forward & reverse motion. New cost over \$15,000. Our price \$6,500.

YOU CAN BANK ON

EQUIPMENT CLEARING HOUSE, INC.
111 33rd Street, Brooklyn 32, N. Y.
SOUTH 8-4451—4452—8782

Dryers, Kilns, Centrifugals, Filters, Kettles, Tanks, Grinders, Crushers, Mixers, Screens, Tablet Machines, etc. Hydraulic, Plastic and Rubber Machinery. Send for bulletins.

STEIN EQUIPMENT CO.

187-8th STREET BROOKLYN 15, N. Y.
Sterling 8-1944

BUY ON TERMS!

BRAND NEW PFAUDLER

Glass Lined Pipe, Valves, Tees and Ells and Reducers. Large quantity in stock. Send for complete list.

LESS THAN 1/2 OF NEW

ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. - San Francisco 7, Calif.

BUY BRILL

REACTORS—EVAPS—CONDS—TANKS

- 3—2000 gal. Struthers Wells 316 S.S. jkt. agtd. Reactors.
- 1—1000 gal. Pfaudler glass lined Reactor.
- 1—550 sq. ft. Bufllovak, monel, single effect Evaporator.
- 1—7500 gal. 316 S.S. Vert. Storage Tank, 7'x25', 50 PSI.
- 1—750 gal. nickel clad Mixing Tank, 125# nickel coils.
- 1—4000 gal. Haveg Vert. Tank 8'x12'.
- 1—1500 gal. Stainless Pressure Tank, 90#.
- 1—12,000 gal. horiz. steel pressure Tank, 7'6"x36', 200 PSI.
- 8—Stainless Heat Exchangers; 1220, 942, 786, 536, 396, 315, 250, 157 sq. ft.

CENTRIFUGALS

- 1—Sharples C-27 Super D-Hydrator, 316 S.S.
- 1—Bird 18"x28" 316 S.S. Solid Bowl, Continuous.
- 1—Bird 18"x28" steel, Solid Bowl, NEW, Continuous.
- 1—Bird 36"x50", 347 S.S. Solid Bowl, Continuous.
- 2—Sharples PY14, PN14, Super-D-Canter, 316 S.S.
- 1—Bird 40" suspended, 347 S.S. perforated basket.
- 2—Sharples #16, 304 S.S., 3 HP motor.

MIXERS

- 1—#12 Sturtevant 304 S.S. Rotary Mixer, 450 cu. ft.
- 1—Baker Perkins #16TRM, 150 gal. jkt., Vac. 60 HP.
- 5—Day "Cincinnatus" double arm, 250 and 100 gal.
- 1—1500# Powder Mixer, 7 1/2 HP XP motor.
- 2—Steel, jkt. Powder Mixers, 225 and 350 cu. ft.
- 1—#0 Simpson Intensive Mixer.

DRYERS

- 1—National 8' x 80', 304 S.S. Apron Conveyor Dryer.
- 1—Louisville 54" x 35', Monel Rotary Steam Tube Dryer.
- 3—Bufllovak Vacuum Shelf, 20 - 60" x 80" shelves.
- 1—Devine Vacuum Shelf with 19-59" x 78" shelves.
- 1—Devine Vacuum Shelf with 10 - 40" x 43" shelves.
- 2—Bufllovak 42" x 120", atmospheric, double drum.
- 2—Devine 5' x 12', 4' x 9', single drum, atmospheric.
- 1—Baker Perkins 5'6" x 6' Rotary Vacuum Dryer.
- 1—Bufllovak 3' x 20' Rotary Vacuum Dryer, 316 S.S. Unused.
- 2—Louisville Rotary Steam Tube 6' x 25', 6' x 50'.
- 4—Rotary Dryers, 4' x 40', 6' x 50', 7' x 80'.
- 2—Louisville 8' x 50' Stainless Steel Lined Rotary Dryers.
- 1—Traylor 30" x 18' Stainless Steel Rotary Dryer.
- 2—Link Belts; 7'5" x 25", 6'4" x 24", S.S. Louvre Dryers.

FILTERS

- 1—Oliver 6' dia. Horizontal Filter, 316 S.S.
- 1—Oliver 3' x 6' Steel Rotary Vac. Precoat Filter.
- 1—Niagara #370-38 Filter, 370 sq. ft., 304 S.S.
- 2—#49 Vallez Rotating Pressure Filters, 738 sq. ft.
- 1—Oliver 5'3" x 8' Steel Rotary Vacuum, vaporite housing.
- 1—Sparkler 33528 Filter, 150 sq. ft. 304 S.S.
- 1—Niagara 36H110 Horizontal Filter, 110 sq. ft., 304 S.S.
- 2—#10 Sweetland Filters, 27 leaves, 4" centers, 250 sq. ft.

MISCELLANEOUS

- 1—Stokes R4 Single Punch Preform Press.
- 1—Nash H10 Hytor Vacuum Pump, 1500 cfm.
- 2—Robinson Sifters, 40" x 84", Stainless.
- 3—Robinson Gyrotory Sifters 30" x 104", triple deck.
- 25—Chlorimet, Durimet and Duriron Centrifugal Pumps 1 1/2" to 6".

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- 1—Patterson 6' x 8' porax pebble mill, 50 HP gearhead drive, 1947—like new.
- 1—Link-Belt #604-18 roto-louvre dryer, 6'4" dia. x 18' long, w/cyclone, fans, etc.

STOCK ITEMS**FILTERS—CENTRIFUGALS**

- 1—Niagara #510-28, 510 sq. ft. vert. leaf, T316 SS.
- 1—Niagara #36H-110-3, 100 sq. ft., vert. leaf, T304 SS.
- 1—Sparkler #33-S-28, 151 sq. ft. horiz. plate, T304 SS.
- 2—Oliver 5'-3" dia. x 3' face rot. vac., pressure precoat, T316 SS.
- 1—Oliver 5'-3" dia. x 8' face rot. vac., precoat, steel, UNUSED.
- 8—Sharples #AS-16V super cent. Inconel, Vapor-tite, 3 HP.
- 6—Sharples #16 super cent., T304 SS.
- 3—Sharples #C-20 Super-D-Hydrators, T316 SS.
- 2—Bird 18" x 28" horiz., cent., T304 SS or steel.
- 1—Bird 32" x 50" horiz., cent., T316 SS.
- 2—Sperry 30" D & F. filter presses, 19-9 st. st. (NI-RESIST)

STAINLESS REACTORS—KETTLES

- 1—3500 gal. T316 SS, jkt. & agit.
- 1—2200 gal. T316 SS, jkt. & agit., VAC.
- 1—1300 gal. T304 SS, jkt., 5 HP XP agit.
- 2—750 gal. T304 SS, jkt. & agit.
- 1—500 gal. T304 SS, jkt. & agit.
- 6—465 gal. T304L SS, jkt. & agit.
- 1—350 gal. T304 SS, jkt. & agit.
- 2—125 gal. T316 SS, jkt.

DRYERS

- 2—Devine 80 sq. ft. Vac. shelf—UN-USED.
- 1—Bufflovak 5' x 12' Vac. single drum—UNUSED.
- 2—Bufflovak 42" x 120" Double Drum.
- 1—American 36" x 84" Vac. Double Drum.
- 1—Bufflovak 32" x 52" Double Drum.
- 1—Allis-Chalmers 7' x 50' rotary, 3/8" shell.
- 2—Hardinge 8'-8" x 70' rotary, 3/8" shell.
- 8—Rotary dryers: 7'-6" x 60', 6' x 50', 4'-9" x 32', 4' x 30', 3' x 15', etc.
- 1—Bartlett & Snow 3' x 15' rotary, ever-dur (95% copper) shell.
- 2—Stainless rotary dryers: 4' x 12' 3' x 10'.

SPECIAL

- 2—7'-6" dia. x 100' long rotary kilns, 1/2" shell.

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LIQUIDATING

CHEMICAL PLANT—ORANGE, TEXAS

- 1—Struthers Wells 630 sq. ft. T316 SS evaporator.
- 2—1,800 cu. ft. Read weight hoppers, T304 SS, 11'10" x 10'5" x 10'2", hopper bottom, fulcrums, scales avail. w/bucket elevators, conveyors, etc.
- 3—Worthington 160 ton steam-jet vacuum refrigeration units.
- 3—18,000 gal. alum. cone-bottom tanks, 12' x 31' OAH.
- 2—Buffalo T316 SS blowers, 2330 cfm, 60 HP. TEFC motors.
- 2—American T316 SS blowers, 5600 cfm., 50 HP. TEFC motors.

CENT.—FILTERS—CRYSTALLIZERS

- 2—Sharples #16-P Pressuritie, T304 SS.
- 2—Sharples C-20 Super D-Hydrators, T316 SS.
- 1—Alco 110 sq. ft. pressure leaf filter, T316 SS.
- 4—Struthers-Wells vacuum crystallizers, 1200 gal., T316 cone bottoms.
- 1—Elmco T304 SS rotary vac. filter, 18" dia. x 24" face.

EXCHANGERS—CONDENSERS—COOLERS

- 12—800 sq. ft. T316 SS heat exchangers, removable bundle.
- 75—T316 tubular heat exchangers & condensers, 2000, 1450, 800, 800, 750, 600, 530, 427, 400, 300, 264, 250, 235, 200, 185, 165, 150, 125, 64, 50, 47, 30 sq. ft.
- 25—Copper & Cupro-Nickel heat exchangers & condensers, up to 1070 sq. ft.

TYPE 316 SS KETTLES

- 1—3,500 gal. Struthers-Wells vert., 7' dia. x 12' high, jacketed, int. coils, 40/20 HP agit.
- 1—2,830 gal. horiz. still kettle, 6' x 12' 100 sq. ft. int. coil.
- 2—2,250 gal. vert., 7' dia. x 6'3" high, jacketed, 3 HP agit.
- 1—2200 gal., 6'6" x 8', vacuum, jacketed, agit. T316 SS.

TYPE 316 STAINLESS STEEL PRESSURE TANKS

- 1—17,500 gal. horiz., 9' dia. x 36' long, 1/4" shell, 3/8" dished heads, 40# WP
- 1—2,800 gal., horiz., 6' x 12', 5/16 shell & dished heads, VACUUM, or 80# WP
- 3—2,750 gal. vert., 7' x 8', dished heads, int. coils, 50# WP
- 9—2,600 gal. vert., 7' x 8', int. coils, 19# WP, 5 HP Agit.
- 5—2,250 gal. vert., 7' x 6'3", dished heads, (some w/agit., some w/jacket), 70# WP
- 2—1,900 gal. vert., 6' x 8', 3/8" shell & dished heads, VACUUM, or 100# WP
- 4—1,200 gal. vert., 5' x 7', dished top, cone bot., VACUUM, or 100# WP
- 1—1,000 gal. vert., 5' x 7', 3/16" shell, 1/4" dished heads, 60# WP
- 6—685 gal. vert., 3' x 13', internal coils.
- 1—575 gal. vert., 4' x 6', dished heads, 90# WP, 355 sq. ft. int. coils.
- 50—Tanks & pots, 30 to 500 gal., T316 SS.

COLUMNS—STAINLESS STEEL

- 1—110" dia. Vulcan, 10 trays—bubble caps, T316 SS.
- 2—96" dia. Vulcan, 30 trays—bubble caps, T316 SS.
- 1—96" dia. Vulcan, 10 trays—bubble caps, T316 SS.
- 2—60" dia. Vulcan, 10 trays—bubble caps, T316 SS.
- 1—48" dia. Vulcan, 25 trays—bubble caps, T304 ELC SS, 100 PSI.
- 3—24" dia. Vulcan, 12 trays—bubble caps, T316 SS—VACUUM.
- 6—T316 SS Packed Columns: 42", 36", 30" dia.
- 5—Steel Packed Columns: 60", 48", 36", 30", 20".

COLUMNS—COPPER

- 5—Vulcan copper bubble-cap columns, VACUUM! 72" x 40 plate; 48" x 25 plate; 48" x 22 plate; 24" x 20 plate.

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- 1500 T316 SS flanged valves, globe or gate, 1/2", 1", 1 1/2" up to 12".
- 7500—T316 SS pipe, schedule 40, 10, 5, sizes 1/2", 1", 1 1/2", 2" up to 12".
- 35—T316 SS pumps, sizes from 6" x 5" to 1" x 1".
- 1—Otis elec. freight elevator, 5,000# capacity @ 75 FPM.
- 2—Stainless steel reollers.
- 2—Stainless steel bucket elevators, 60' & 40' high.
- 1—2,100 gal. vert. alum. tank, coils.
- 10—T316 SS separators, 22" x 8' deep.
- 1—2,000 gal. copper tank.
- 3—18,000 gal. steel tanks.

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- 2—Pfaudler 750 gal. glass lined jacketed reactors
- 9—Davis Engineering SS heat exchangers 145 sq.ft (NEW)
- 1—Shriver aluminum 30"x30" plate and frame filter press, 30 chambers
- 2—Fletcher 40" suspended type rubber lined centrifuges with perforated baskets and motors.

AUTOClaves KETTLES AND REACTORS

- 2—Horizontal stainless steel 3000 gal. storage tanks
- 1—Steel and Alloy Tank Co. 100 gal. type 347 SS pressure tank, 250 psi jacket
- 1—Blaw-Knox 400 gal. steel jacketed autoclave, 570# internal pressure, 85# jacket
- 1—Blaw-Knox 45 gal. jacketed autoclave, 1500# pressure
- 1—Process Engineers SS jacketed reactor, 1500 gal., 140# W. P. jacket, 150# W. P. shell
- 1—Steel & Alloy Tank Co. SS jacketed tanks, 500 gal. each
- 2—Pfaudler 200 gal. glass lined reactors with impeller type agitators and drives
- 1—Pfaudler 500 gal. glass lined jacketed reactor, complete with impeller type agitator, baffle and drive.
- 1—Pfaudler 50 gal. glass lined jacketed reactor complete with agitator and drive
- 1—Edgemoor type 316 SS 750 gal. jacketed reactor
- 1—Struthers Wells 500 gal. nickel jacketed reactor
- 1—Patterson-Kelley 6000 gal. steel jacketed reactor, 40# jacket, complete with agitator and drive
- 1—Patterson 2000 gal. steel jacketed reactor
- 2—Haveg 300 gal. pressure vessels complete with agitators and drives
- 28—30,000 gal. steel vertical storage tanks

DRYERS

- 1—Link Belt steel roto louver dryer, Model 1003-30
- 3—Link Belt steel roto louver dryers, Model 207-10, 310-16, 604-20
- 2—Stokes Model 138J-20 single door vacuum shelf dryers, 20 shelves, complete
- 1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
- 1—Bullovak SS rotary vacuum dryer, 3' x 15'
- 1—Stokes double drum dryer, 5' x 12'
- 1—Louisville rotary steam tube dryer, 8' x 45'
- 2—Louisville SS rotary dryers, 8' x 50'
- 1—Louisville SS rotary kiln, 30" x 28' complete
- 1—Louisville Rotary Dryer, 38" x 40' Type L
- 1—Ruggles Coles 4' x 30' rotary kiln
- 1—Traylor 4' x 40' rotary dryer
- 1—rotary dryer 6' x 36'

FILTERS

- 3—Dorrco rubber covered filters, 6' x 2'
- 1—Sweetland #3 stainless steel filter
- 1—Niagara SS filter, Model 510-28
- 1—Oliver horizontal filter, 3'
- 10—Shriver plate and frame filter presses, 12" to 42"
- 1—Shriver C.I. plate and frame filter press, 36" x 36" closed delivery, 4 eye, 60 chambers
- 1—Shriver rubber line filter press 36" x 36"
- 12—Sweetland #12 filters with 72 SS leaves

CENTRIFUGES

- 1—Tolhurst 40" SS suspended type centrifuge complete with plow and motor with imperforated basket



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- 1—Tolhurst SS 20" suspended type centrifuge with perforated basket, complete with plow and motor
- 1—AT&M 26" suspended type centrifuge with SS perforated basket, complete with plow and motor
- 1—AT&M 48" SS suspended type centrifuge, complete with plow motor and imperforated basket
- 1—Bird type 316 SS centrifuge, 32" x 50"
- 4—Tolhurst 30" center slung rubber covered centrifuges with perforated baskets and motors
- 18—Sharples SS centrifuges, Model 16Y

MIXERS

- 15—Robinson type 304 SS horizontal blenders, 255 cu. ft. each
- 3—Robinson type 316 SS sigma blade jacketed heavy duty mixers, 400 gal.
- 1—Baker Perkins Size 16 Type UUEM 150 gal. jacketed double arm dispersion type mixer, complete with compression cover and 100 HP motor.
- 2—Sturtevant #7 dust type rotary batch blenders, NEW
- 1—12' x 4' pug mixer, type 316 SS
- 1—Patterson type 34 7SS jacketed vacuum sigma kneader master, 500 gal.

MISCELLANEOUS

- 1—Cleaver-Brooks 500 HP package steam generator, 200#
- 2—Cleaver-Brooks package steam generators, 50 & 80 HP, 125#
- 2—Heat Transfer Products steel bubble cap columns, 36" and 42" with 5 and 10 trays
- 1—Acme steel bubble cap column, 42" dia. with 10 trays
- 1—Badger type 316 SS bubble cap column, 42" dia. with 11 trays
- 1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays
- 1—Vulcan SS bubble cap column, 4' x 28 plates
- 2—Patterson-Kelley steel heat exchangers, 1000 sq. ft. each
- 6—Struthers Wells heat exchangers, 885 sq. ft.
- 1—Patterson-Kelley steel heat exchanger, 427 sq. ft.
- 50—Steel heat exchangers from 15 sq. ft. to 400 sq. ft.
- 1—Downington type 316 SS heat exchanger, 750 sq. ft.
- 1—Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
- 1—Condenser Service type 316 SS heat exchanger, 350 sq. ft.
- 3—Badger type 316 SS heat exchangers, 500 sq. ft. and 600 sq. ft.
- 3—Robins shaker screens, SS, 3' x 6'
- 1—Swenson type 316 SS vacuum crystallizer, 3'6" x 12'
- 1—Swenson type 316 SS vacuum crystallizer, 2' x 12'
- 1—Blaw-Knox steel distillation column, 36" x 40' with 24 trays (NEW)
- 3—Williams type 316 SS hammermills, Model AK
- 1—Swenson SS pilot plant spray dryer

- 1—Oliver SS rotary pressure precoat filter, 5'3"x8'
- 1—Glenn SS 340 qt. mixer
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- 1—Stokes Model T tablet press



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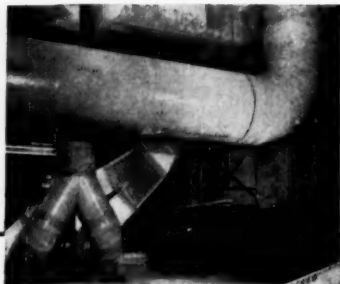
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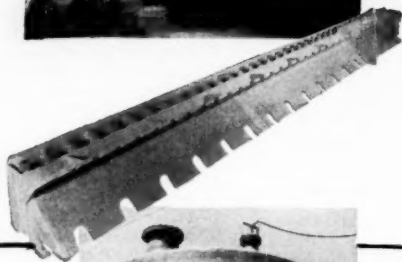
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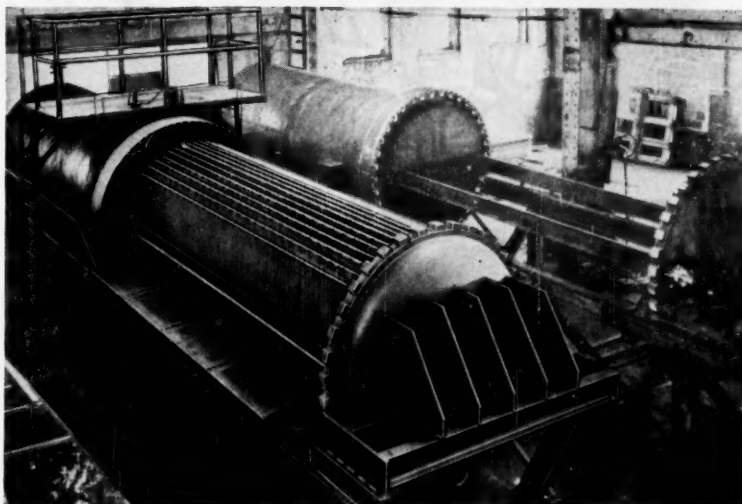
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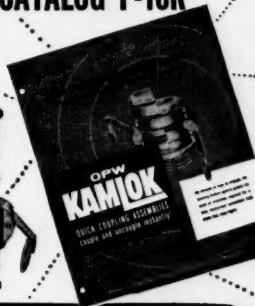
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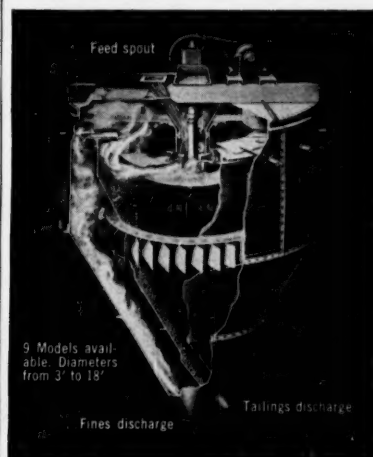
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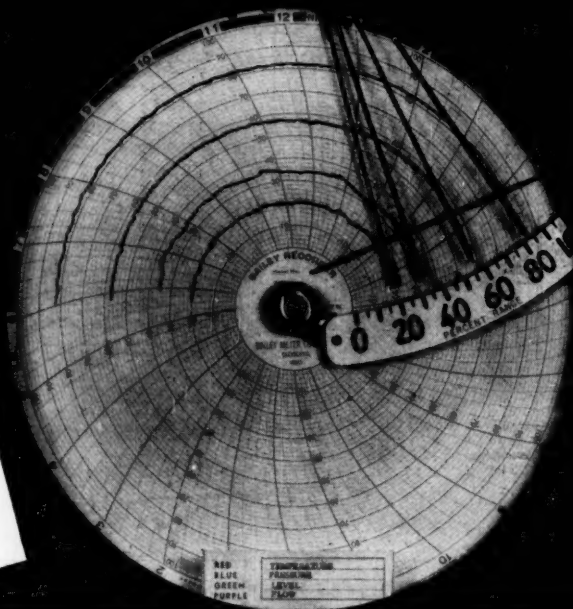
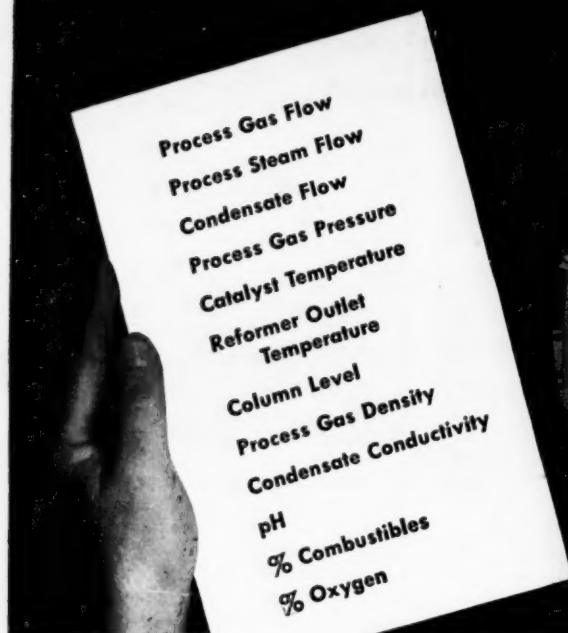
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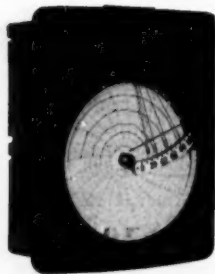


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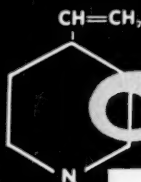
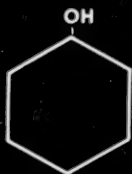
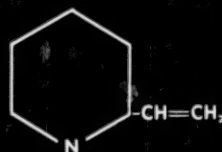
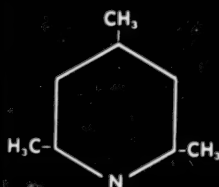
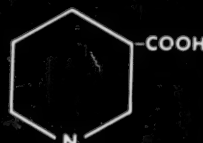
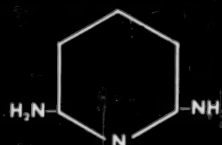
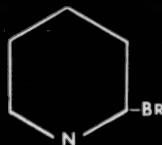
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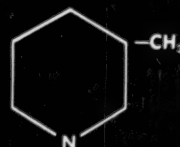
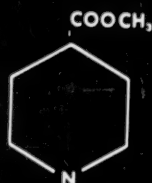
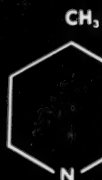
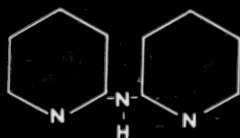


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